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THE WORK OF THE YUMA RECLAMATION PROJECT EXPERIMENT FARM IN 1918

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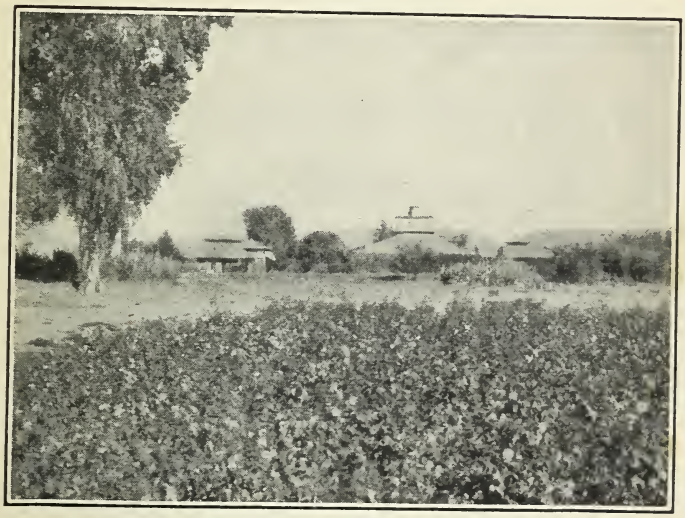

A Breeding Block of Upland Cotton and Buildings on the Yuma Experiment Farm

UNITED STATES DEPARTMENT OF AGRICULTURE
DEPARTMENT CIRCULAR 75

Contribution from the Bureau of Plant Industry
(Office of Western Irrigation Agriculture)
WM. A. TAYLOR, Chief

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THE PROGRESS OF AGRICULTURAL DEVELOPMENT.

The era of increased agricultural prosperity which existed on the Yuma project during 1917 continued through 1918. There were no important variations in the average production per unit area from the previous year with the exception of the cotton and live-stock industries, from which the returns were lower. Statistics which are annually assembled by the United States Reclamation Service show that the average gross returns per acre from the entire area cropped was $113.32, which was an increase of $7.85 over that of the previous year. However, it does not follow that the average net returns to the farmer were greater or even equal to those obtained in 1917, as the cost of production was much greater. The production of the principal crops, ranked either in order of their total gross returns or the area cultivated, were as follows: Cotton, alfalfa hay, alfalfa seed, grain sorghums, pasture, and small grains. In a comparison of the average gross return per acre, the field crops grown assumed the following rank: Cotton, broom corn, alfalfa seed, alfalfa hay, beans, grain sorghums, and small grains. The average gross returns per acre of fruit and truck crops were both greater than any field crop, but the areas were small and of minor importance except as they were valuable to the farmer for home use.

The live-stock industry did not increase in comparison with the expansion of the area cropped.

THE YUMA RECLAMATION PROJECT.

The Yuma Reclamation Project embodies a total area of 110,000 acres located in the States of California and Arizona. Of this area, 65,000 acres is valley land lying along the Colorado River, all of which

is irrigable, and 45,000 acres is mesa land, which parallels the valley. The valley lands were originally covered with trees or bushy shrubs, which growth was maintained by the annual overflow of these areas by the Colorado River. In some locations there occurred a very dense growth of mesquite and screw-bean trees, such as are shown in figure 1, while other areas were densely overgrown with arrowweed brush, frequently interspersed with groves of large cottonwood and willow trees, such as are shown in figure 2. The mesa lands do not overflow, and they maintain only a sparse natural vegetation.

THE LEVEE SYSTEM.

In order to make the valley lands secure from flood damage, a rather extensive protective system of levees was necessary; conse-

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FIG. 1.—Virgin growth of mesquite trees on valley lands of the Yuma Reclamation Project.

quently, all of these lands are now guarded from the river overflow by a combined length of 70 miles of levee. These were at first simple earth embankments placed at some distance from the stream and were undamaged by river floods until the spring of 1909. Since that time considerable difficulty has been experienced each year in maintaining some part of the levee system. The flood danger has not been from pressure against the levees, but from erosion occurring in certain places caused by the meandering of the river at flood stage. Many sections have been improved and strengthened from time to time by revetment of rock being placed on the river slope of the levee, and railroads have been placed on the entire system. The need of levee railroads and equipment is very acute at times for the immediate delivery of rock to those portions of the levee where erosion is in progress.

DIVISIONS OF THE PROJECT.

Certain natural boundaries and different problems of development have aided in the designation of arbitrary divisions of the Yuma project lands. An area of about 15,000 acres of valley land is on the California side of the Colorado River, which is about equally divided into two tracts known as the Bard unit and the Indian Reservation unit. The remaining 50,000 acres of valley land are in Arizona, being known as the lower Yuma Valley unit.

Bard unit.—The Bard unit consists of 173 farms, varying in area from 20 to 40 acres, of land that was originally included in the Yuma Indian Reservation and opened to entry in 1910.

P2630W1

FIG. 2.—Virgin growth of cottonwood and willow trees, with arrowweed in the foreground, on valley lands of the Yuma Reclamation Project.

The Yuma Indian Reservation unit.—This unit includes nearly 8,000 acres. It has been subdivided in 10-acre tracts, and allotted to the Indians of the Yuma tribe. The greater part of this unit is now in cultivation, being farmed partly by the Indians themselves, but more extensively by white farmers who have leased this land under an arrangement that it must be cleared, leveled, and put in cultivation while the lessee is compensated by the use of the land for a period of five years. Some of this land has now passed the first 5-year period of lease and is being farmed by the Indian owner or re-leased to white farmers.

Lower Yuma Valley unit.—Some of the land of the lower Yuma Valley unit of the Yuma project had been under irrigation for many years before this area was taken over by the United States Reclamation Service. Upon investigation in 1903, it was found that a few

farmers were endeavoring to irrigate through three ditch systems constructed by cooperative companies. These were purchased by the Reclamation Service during 1907 and 1908 and operated without important expansion until June 29, 1912, when the Colorado River siphon at Yuma was completed. Since that date gravity water has been available.

A few homesteads of Government land have been opened to settlers in this area, but the greater part of this unit is of land that was already under private ownership. The maximum area to which any one person may ultimately hold a water right in this unit has been announced by the Department of the Interior as 160 acres.

The Yuma Mesa unit.—The Yuma Mesa unit is an area of relatively level sandy or gravelly land which lies parallel to the Yuma Valley. This land has an altitude ranging from 60 to 70 feet above the adjacent valley lands and must be supplied with water lifted from the valley level. The winter temperatures are sufficiently mild over this area to permit the growth of semitropical fruits and vegetables. At this time only a small acreage of this land has been improved. The Reclamation Service is not yet pumping water to this tract and the present limited development is by independent enterprise, although a part of the water is obtained from Reclamation Service canals in the valley.

The Gila Valley unit.—The Gila Valley unit, which lies in Arizona, north of the Gila River, near its junction with the Colorado River, has been supplied with water by diversion at the Arizona heading of the Laguna Dam since 1911. This unit was turned over to the water users under date of September 29, 1918, to be operated by a local irrigation district known as the North Gila Valley Irrigation District. At the present time an area of about 1,000 acres is being cultivated in this tract.

THE IRRIGATION PLAN.

The irrigation plan of the Yuma project provides for the diversion of water from the Colorado River at the Laguna Dam, which is about 13 miles northeast of Yuma, into the main canal on the California side of the river. Through this canal, water is supplied to the Bard and Indian Reservation units and also is conveyed through 13½ miles of canal, where it is conducted under the Colorado River at Yuma through an inverted siphon to canals supplying the lower Yuma Valley and the Yuma Mesa units of the project. A view of this canal, carrying a large stream of water, appears in figure 3.

THE LAGUNA DAM AND THE YUMA SIPHON.

The two principal engineering features of the Yuma project are the Laguna Dam and the Yuma siphon. The Laguna Dam is not a

storage reservoir, but a diversion dam of the Indian weir type and acts only as a diversion structure. The dam is 4,780 feet long and raises the water level 19 feet above the old river-bed level. This structure was completed in 1909, and water was first diverted through the irrigation system the following year. One of the important features of this diversion system is the desilting arrangement, whereby much sediment is eliminated from the water as it is diverted at each end of the dam. These settling basins, with the sluiceways

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FIG. 3.—A view of the main canal between the Laguna Dam and the Yuma siphon.

provided, have proved efficient in removing at least 25 per cent of the sediment carried by this water, which includes mainly the heavy sands and also a variable amount of the silt which is in suspension.

Figure 4 is a view of the Laguna Dam extending across the Colorado River, with the north side settling basin in the foreground.

In figure 5 is shown the north side settling basin and the gates through which the diverted water is skimmed off from the quiet lagoon in the settling basin.

The Yuma siphon is located near the town of Yuma. This structure is an inverted siphon, which consists of circular concrete shafts connected by a circular concrete-lined tunnel, 930 feet long. The diameter of the siphon is 14 feet, and it has a capacity of 1,400 second-feet. The siphon conducts ditch water by gravity from the California side of the Colorado River under the river to the Arizona side, and supplies nearly all land of the project south and west from there. It was completed on June 29, 1912.

THE COLORADO RIVER WATER SUPPLY.

As stated in a previous paragraph, the Yuma project is supplied entirely by water from the Colorado River. While the Gila River joins the Colorado on the project, no local use is made of the intermittent flow of this stream. The flow of the Gila River is due entirely to rains in southern Arizona, which generally occur during

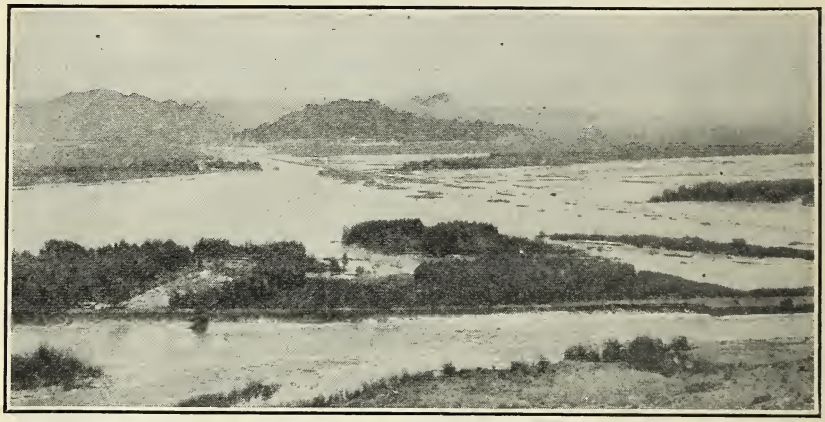

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FIG. 4.—A view of the Laguna Dam with the north side settling basin in the foreground.

the autumn and winter months. The Colorado River has a drainage area above the Laguna Dam of approximately 229,000 square miles. The mean annual run-off which passes Yuma is reported as 16,955,810 acre-feet for the past period of 17 years. This figure represents the discharge of the Colorado River at the Laguna Dam, plus the mean annual discharge of the Gila River, which joins the Colorado between Yuma and the Laguna Dam. Since the earliest observations relative to the operations on the Yuma project there has never occurred a time when the water supply at Laguna Dam was inadequate for ample irrigation of all the land under the Yuma project. The annual spring freshet usually reaches this point early in June and may extend through the month of July.

METHOD OF IRRIGATION.

The practice of applying water which is almost exclusively followed on the Yuma project is typical of that method commonly

termed "the flooding system." The area of each land or border averages about 1½ acres, usually being about 660 feet long, and varies from a very slight grade to an actual level within the border. The usual head of irrigation water delivered to the farmer is 12 second-feet, and at this rate he may irrigate about 2 acres per hour. Water is delivered by the Reclamation Service on a 7-day rotation schedule during the main growing season and semimonthly during the winter months.

THE DRAINAGE SYSTEM.

The drainage system already developed in the Bard and Yuma Indian Reservation units has to a great degree solved the drainage problems of those areas, but a condition of high ground water has gradually developed in the soil in certain sections of the lower Yuma Valley unit as farm development and irrigation have been extended.

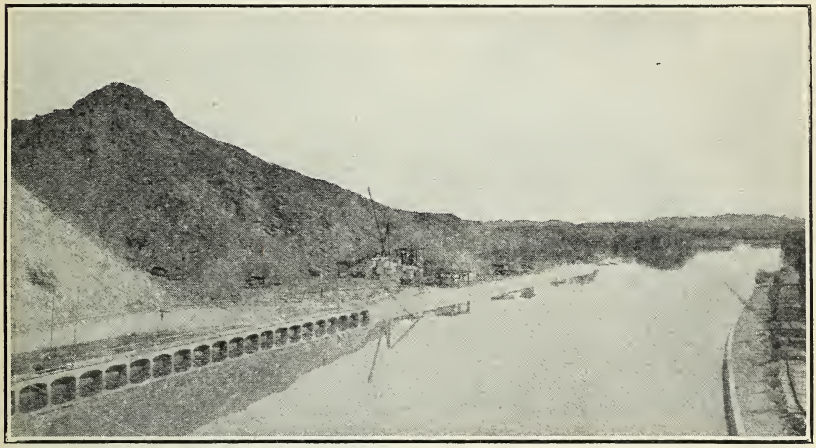

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FIG. 5.—The north side settling basin and diversion gates at the Laguna Dam.

This condition in a few localities had become so critical as to cause some alarm. Construction work of drainage canals, such as will be necessary to drain these areas, was begun by the Reclamation Service in 1917 and is still in progress. By the study of the location of ground water through a system of test wells, the Reclamation Service found that the general rise of ground water was not equal to last year, but this was probably due to the fact that in 1917 there was quite a high river for a long period of time, which caused a very noticeable rise in the ground-water plane, while in 1918 the flood did not reach so high a stage or continue as long. A view of one of the main drainage canals on the Indian reservation unit is shown in figure 6.

CONSTRUCTION WORK IN 1918.

The construction work on the project carried out by the Reclamation Service consisted mainly of the building of the Yuma Valley

Drainage Pumping Plant at the Mexican boundary, and the extension of the Yuma Valley Main Drainage Canal. Work was begun on this pumping plant in November, 1917, and completed in August, 1918. The finished plant consists of a concrete building 72 feet long by 44 feet wide, equipped with two wood-screw pumps, each driven by an oil engine. These pumps have a combined capacity of 75 second-feet. The building is designed and built for the addition of two other units of 50 second-feet capacity each that may be installed when needed.

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FIG. 6.—The main drainage canal on the Indian Reservation unit of the Yuma Reclamation Project.

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

Weather conditions during 1918 were generally favorable for all crops except cotton. The winter temperatures were unusually mild, which permitted Bermuda grass and some other perennial weeds to pass through the winter without being sufficiently damaged to allow of easy control. Also, a better opportunity was afforded insect pests

to survive during the winter, which may to a degree explain the prevalence of the cotton aphis during the spring and early summer. Other climatic conditions suitable for this pest occurred during June, as cloudy weather and high humidities prevailed. Dry hot weather are conditions desirable for its control. Very sudden and extremely high temperatures during August also damaged the cotton crop, causing an abnormal shedding of squares and young bolls in fields of Upland cotton. However, the unfavorable climatic conditions that wrought the greatest loss to the cotton farmers was the freeze that occurred on the night of November 6, with a minimum temperature of 29.5° F. at many points in the valley. Frosts occurred three nights in succession and were sufficiently severe to stop the growth of nearly all crops, such as cotton, grain sorghums, broom corn, and sweet potatoes. This freeze was about two weeks earlier than the normal date for the first killing frost, and it is estimated that on account of it cotton yields were reduced about 15 per cent.

The lowest minimum temperature of the year was 19° F., which occurred in December. The highest temperature recorded, 115° F., occurred on August 2. The latest spring frost was on February 19, although the nights remained too cold for the best growth of crops until the month of April. There was a frost-free period of 261 days, which is a slightly longer period than the average since 1910. However, the early frost-free time of the spring did not compensate for the early autumn freeze. The calculations of mean temperatures, as shown in Table I, indicate that the yearly mean was about normal, but there was considerable monthly variation. In May, August, November, and December the temperatures were below normal. Other months were normal or slightly above normal, except June, which obtained a mean daily temperature about 7 degrees higher than the average for the previous eight years.

The meteorological data embodied in this report are from observations made at the experiment farm and represent the actual conditions in much of the valley land of the project. Temperatures are found to vary from those recorded at the Yuma office of the United States Weather Bureau, as those observations are more nearly representative of temperatures that occur on the higher lands of the project. During the four months of ordinary frost—November, December, January, and February—the minimum temperatures at Yuma are generally from 5 to 8 degrees higher than in the valley, while the maximum temperatures average about 1 degree less. Throughout the remaining eight months of the year the minimum temperatures are from 8 to 10 degrees higher on the mesas than in the valley, and the maximum temperatures are ordinarily 1 to 2 degrees higher.

TABLE I.—*Summary of meteorological observations at the Yuma Experiment Farm for the 9-year period from 1910 to 1918.*

PRECIPITATION (INCHES).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Average for 9-year period	0.765	0.327	0.396	0.160	0.084	0.586	0.417	0.375	0.122	0.272	0.324	0.280	4.11
For 1918	1.15	.12	.74	.....	.....	.09	.06	.48	.01	.50	.07	.35	3.57

EVAPORATION (INCHES).

Average for 9-year period	2.939	3.853	6.220	6.933	9.608	10.205	9.850	9.231	7.315	5.639	3.787	2.752	78.332
For 1918	2.803	3.400	4.903	7.269	9.649	9.890	9.598	8.129	16.578	4.803	3.651	2.342	73.015

DAILY WIND VELOCITY (MILES PER HOUR).

Average for 9-year period	2.7	3.0	3.1	3.1	3.1	2.4	2.2	1.9	1.7	2.0	2.3	2.5	.....
For 1918	2.0	2.5	2.4	2.5	2.9	1.8	1.5	1.5	1.0	.92	1.9	1.5	.....

TEMPERATURE (° F.).

Absolute maximum:													
For 9-year period	84	88	99	106.5	120	117	116	115	116	109	94	82	120
For 1918	82	79	92	95	98	112	110	115	105	100.5	94	78	115
Absolute minimum:													
For 9-year period	16	26.5	30	32	33	43	55	54	44	36	28	16	16
For 1918	27	26.5	38.5	37	42	43	59	56	52	36	29.5	19	19
Mean:													
For 9-year period	52.24	55.86	61.65	67.35	73.29	81.81	87.70	86.98	81.49	70.33	60.18	50.88	69.15
For 1918	52.06	55.80	63.50	66.82	70.81	87.02	88.00	85.14	82.20	71.94	59.22	49.68	69.35

KILLING FROSTS.

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		° F.		*° F.*	*Days.*
1910	.....	.....	Nov. 27	32	.....
1911	Feb. 24	32	Nov. 24	32	262
1912	Mar. 31	32	Dec. 4	31	247
1913	Mar. 28	32	Dec. 2	31	248
1914	Mar. 4	31	Dec. 4	32	275
1915	Mar. 3	31	Nov. 13	31	254
1916	Mar. 25	31.5	Nov. 17	31	237
1917	Mar. 13	30	Nov. 29	32	260
1918	Feb. 19	29	Nov. 7	29.5	261

The precipitation which occurred at the experiment farm during 1918 was 3.57 inches, being distributed through all months except April and May. The greatest amount of this light rainfall came in January, March, August, and October. The total precipitation for the year at the Yuma Weather Bureau station was only 2.9 inches, which again indicates the very local nature of the small rains in this region. Evaporation for the year was about 7 per cent less than normal, showing a total of 73.02 inches. Observations of humidity recorded

three times daily have shown the average conditions of humidity for the year to be normal, except during the month of June and the early part of August, when high humidities obtained for continued periods.

The annual spring flood of the Colorado River reached the highest mark on the river gauge at Yuma on June 26, with a discharge of 90,700 second-feet, but the maximum discharge, which was 94,300 second-feet, did not reach Yuma until July 3 and showed a gauge reading of 11 inches lower than the former. This condition frequently develops during relatively long periods of flood and is a relief to the strain on the levees as the river channel scours deeper. An earlier freshet occurred in April, which damaged the levees in some places, but during all floods the Reclamation Service was very successful in maintaining the levee system. The area of land immediately adjacent to the river levees that sometimes has suffered crop damage by seepage conditions during the high flood stage of the Colorado River experienced some injury again this year, but most of these farms have been exchanged for other public land of better situation, while the former land has been leased by the Government for grazing purposes.

The climatological observations made at this station during the 9-year period from 1910 to 1918, inclusive, are summarized in Table I.

IRRIGATION DEVELOPMENT.

The total number of new farms brought under irrigation during the past year was 285, being an increase of nearly one-third of the number of farms that were operated during 1917. This was partly due to subdivisions of acreages above 80 acres, but chiefly to the clearing and leveling of new land. The actual increase in area irrigated above that of the previous year amounted to 8,714 acres. Compared to the acreage that the Reclamation Service was prepared to irrigate in 1918, 62.6 per cent of such land was being farmed. The census figures, as summarized in Table II, show an increase during 1918 in the farm population on the Yuma project of 1,600 people, which includes not only the population on new farms operated but a slight increase of the average number of people per farm on the entire project. The number of people actually engaged in agricultural work on the irrigated land in 1918 was 2,135, or one individual to every 21.3 acres. The total urban population on the project was about 11,980. The development of irrigation on the Yuma project for the 7-year period from 1912 to 1918, inclusive, is summarized in Table II.[1]

[1] The figures in Tables II to V and XXXI have been taken from data collected by the local office of the United States Reclamation Service in annual census reports. The writer desires to express his appreciation for the use of these records, which embody information of general interest.

TABLE II.—*Summary of irrigation development on the Yuma Reclamation Project during the 7-year period from 1912 to 1918, inclusive.*

Items of comparison.	1912	1913	1914	1915	1916	1917	1918
Water diverted.....acre-feet..	96,409	127,307	205,207	246,786	249,700	337,597	314,900
Water delivered:							
To farms.....do.....	63,273	85,411	93,167	92,897	94,393	136,541	150,229
Per acre irrigated.....do.....	7	4.36	3.69	3.34	3.20	3.7	3.3
Length of canals operated.....miles..	173	227.5	249.5	307.3	316	335	338
Land area:							
Irrigable.....acres..	38,500	50,000	60,000	72,440	72,440	72,440	73,000
Irrigated.....do.....	13,767	19,607	25,207	27,857	29,483	36,956	45,670
Cropped.....do.....	11,060	16,726	22,568	25,101	28,283	35,578	45,049
Irrigated farms.....number..	470	616	698	737	790	900	1,185
Average population per farm.....	3.2	2.7	3.6	2.8	2.6	3.0	3.63
Total population on farms.....	1,490	1,793	1,815	2,036	2,002	2,700	4,300
Owners on farms.....	.....	496	468	659	453	505	700
Tenants on farms.....	.....	120	129	249	297	339	485
Value of crops:							
Total.....dollars..	497,103	610,228	709,409	873,721	1,435,403	3,752,669	5,105,132
Per acre cropped.....do.....	44.90	36.48	31.43	34.43	50.00	105.47	113.32
Per farm.....do.....	1,057.50	993.00	1,016.00	1,185.51	1,816.90	4,169.52	4,308.13
Value of live stock per farm.....do.....	952.00	1,250.00	1,201.00	1,071.80	1,018.80	905.46	707.96

The number of farms being operated by tenants decreased from 56.2 per cent during 1917 to 40.9 per cent during 1918. This condition was probably due in part to the fact that the prospects for good prices induced many landowners to operate their own farms, but was also partly brought about by the loss of many renters who enlisted in the military forces or took up special war industrial work.

Some encouraging results were accomplished this season on certain tracts of land that have previously been too alkaline to produce crops. These results in all cases reflected the value of better drainage associated with the washing down of the alkali salts by systematic heavy flooding of the soil.

CROP CONDITIONS.

The prevailing high prices being paid for cotton stimulated cotton production on the Yuma project to such an extent in 1918 as to decrease materially the acreage of other crops. The yields and farm values of all crops grown on the Yuma project in 1918 are recorded in Table III.

COTTON.

Nearly 64 per cent of the entire irrigated area of the project, or 28,608 acres, was planted to cotton. This was an increase of 125 per cent above the 1917 area. Although the average price received for this crop was only 7.2 cents a pound less than in 1917, there is shown a decrease of $46.37 average gross return per acre. This reduction of average return per acre is partly due to the smaller acreage of Egyptian cotton produced in 1918, which is always more valuable than Upland cottons, but more largely due to a falling off of the average yield per acre, which was 8.2 per cent less than the 1917 yield. Much difficulty was experienced by the growers in disposing of the Egyptian cotton, and also the marketing of American Upland

cottons was not satisfactory after midwinter. In the early spring of 1919 there was a large quantity of each of these types of cotton that had not been marketed. The unit prices shown for these cottons in Tables II and III are an average for that which had been sold up to December 31, 1918.

TABLE III.—*Yields and farm values of crops grown on the Yuma Reclamation Project in 1918.*

Crop.	Area (acres).	Unit of yield.	Yields.			Farm values.		
			Total.	Per acre.		Per unit of yield.	Total.	Average per acre.
				Average.	Maximum.			
Alfalfa hay	8,929	Ton	28,695	3.21	10	$19.35	$565,322	$63.31
Other hay	593	...do	975	2.00	1.6	13.57	13,234	22.32
Alfalfa seed	4,577	Pound	1,690,352	369.3	950	.23	380,216	83.06
Barley	425	Bushel	12,053	28.3	60	1.43	17,292	40.68
Wheat	460	...do	9,343	20.3	50	1.90	18,664	40.57
Grain sorghums	4,118	...do	174,631	42.4	70	1.04	181,361	44.04
Corn fodder	216	Ton	549	2.5	5	10.04	5,515	25.53
Cotton:								
Egyptian	2,915	Pound	710,763	244	500	.50	355,381	121.91
American Upland varieties	25,693	...do	10,143,762	395	800	.28	2,840,253	110.15
Total	28,608	...do	10,854,525	379.4	800	.294	3,159,634	111.69
Seed	28,608	Ton	10,597	.37	.8	58.00	614,626	21.45
Broom corn	42	...do	15	.3	.5	271.67	4,075	97.02
Beans	28	Bushel	410	14.6	20	3.31	1,356	48.43
Truck	160				200		13,956	87.23
Fruit	46				300		5,558	120.83
Pasture	2,342				50		44,848	19.18
Additional revenue [1]							43,475	
Less duplications	62,711						3,159,634	
Total	45,049						5,105,132	
Average								113.32

[1] From pasturing alfalfa straw and pasturing stalk lands.

The Egyptian cotton produced was nearly all of the Pima variety. However, the mild winter allowed many of the plant roots of the previous crop to remain alive, and a few fields of the Yuma variety were ratooned as a 1918 crop. The American Upland cotton grown consisted of the long-staple Upland variety Durango and the short-staple varieties Triumph (Mebane) and Rowden. A view of a field of Triumph cotton grown on the Yuma project in 1918, which produced a yield of 1½ bales per acre, is shown in figure 7.

As already stated under "Climatic conditions," the season as a whole was not normally favorable to the cotton crop. Yields were also greatly reduced in some areas by the ravages of the bollworm, cotton aphis, and several species of plant bugs. Most growers did not plant cotton as early as during past seasons, as the spring nights remained cool rather later than usual. This condition, coupled with much drying wind in April, necessitated considerable replanting. Cotton chopping was nearly all completed by June 10. In the earliest planted fields of short-staple varieties and in ratooned fields of Egyptian cotton, a few bolls were open by July 5. It is not expected

that cotton will continue to be grown on such a large proportion of the land on the Yuma project as in 1918.

ALFALFA.

The area devoted to the production of alfalfa hay and seed was the smallest for six years. This was due entirely to the expansion of the cotton acreage, as old alfalfa land is always good cotton land. The area utilized for hay production was nearly one-third less than

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FIG. 7.—A field of Triumph (Mebane) cotton grown on the Yuma Reclamation Project in 1918.

the previous year, while the average yield per acre was about the same. The average price per ton was $19.35, which is $4.35 higher than for any year since the project has been opened. Alfalfa seed was produced on about the same acreage as in 1917, while the average yield per acre is 33 pounds greater than in any previous year of the history of the project. The average value of seed per pound was about 6½ cents more than last year. However, the continued growing demand over the Southwest for good hairy-leaved Peruvian alfalfa

absorbed all of the seed of this variety early in the season, and it later sold at 49 cents a pound. The demand for seed of this variety for local planting was also great, as a large percentage of the alfalfa plantings now being made on the Yuma project are of the hairy-leaved Peruvian variety. A constructive piece of work in the local alfalfa-seed industry has been begun by the Yuma County Farm Adviser through inspection of alfalfa seed fields and certification as to the purity of the variety of the seed that is produced. Such inspection and certification are very important, inasmuch as three varieties of alfalfa are being grown on the project and many fields have become mixed.

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FIG. 8.—A field of feterita in the shock on the Yuma Reclamation Project.

GRAIN SORGHUMS.

The area producing grain sorghums was 40 per cent less than the previous year, but the average yield per acre and the price received were slightly greater. The varieties most extensively grown were Dwarf milo and feterita. A few fields of Dwarf hegari and Dwarf Blackhull kafir were also produced. As the market value of alfalfa hay was so high, much grain sorghum was harvested with corn binders and fed to live stock. In figure 8 is shown a view of a field of feterita which has been harvested in this manner and shocked in the field.

WHEAT AND BARLEY.

Only a small area was devoted to the production of wheat and barley in 1918. The average yield per acre and the prices received did not vary much from those of last year. The main wheat varieties grown

were Sonora and Early Baart. Unfortunately, no particular attention has been given to barley varieties up to date. Both of these grains are frequently used as a companion crop with autumn-seeded alfalfa or are seeded alone to be harvested as a hay crop.

TABLE IV.—*Acreage, production, and farm values of the principal crops grown on the Yuma Reclamation Project in the 8-year period from 1911 to 1918, inclusive.*

Item and year.	All crops.	Alfalfa hay.	Alfalfa seed.	Grain sorghums.	Wheat and barley.	Cotton.[a]
Acreage:						
1911	8,570	3,750	[b] 2,600	420	1,290	30
1912	4,060	7,269	2,824	986	1,567	25
1913	16,726	10,321	3,388	2,928	1,586	62
1914	22,568	10,426	5,485	3,066	2,223	2,268
1915	25,101	9,441	6,449	6,408	3,838	709
1916	28,283	10,880	8,100	4,897	1,651	4,670
1917	35,578	12,901	4,643	6,883	900	12,706
1918	45,049	8,929	4,577	4,118	885	28,608
Production:		*Tons.*	*Pounds.*	*Bushels.*	*Bushels.*	*Pounds.*
1911		16,327	576,730	13,106	39,083	15,000
1912		27,078	814,186	31,372	55,375	5,800
1913		38,100	1,139,100	112,597	45,075	19,610
1914		32,525	1,246,318	100,153	61,674	845,044
1915		24,277	1,669,020	231,185	88,182	359,850
1916		28,029	2,635,800	195,799	35,306	2,289,430
1917		43,177	1,588,500	280,539	25,057	5,253,454
1918		28,695	1,690,352	174,631	21,396	10,854,525
Average yield per acre:						
1911		4.36	222	31.5	30.6	500
1912		3.73	288	31.8	35.3	232
1913		3.69	336	38.5	38.4	316
1914		3.12	227	32.6	27.8	373
1915		2.57	258.6	36.1	22.9	507.6
1916		2.58	325.2	39.97	21.39	490
1917		3.3	342	40.00	27.84	413.5
1918		3.21	369.3	42.4	24.18	379.4
Farm values per unit of yield:						
1911		$15.00	$0.16	$0.854	$0.66	$0.20
1912		10.00	.10	.75	.75	.20
1913		7.53	.111	.513	.668	.21
1914		6.05	.13	.70	.676	.08
1915		7.15	.1475	.63	.739	.109
1916		9.52	.1247	.64	.835	.174
1917		15.00	.1655	1.00	1.22	.366
1918		19.35	.23	1.04	1.68	.294
Farm values per acre:						
1911	$51.80	65.44	32.52	23.62	20.20	100.00
1912	44.94	37.30	28.80	23.85	26.47	46.40
1913	36.48	27.83	37.33	19.72	18.95	66.50
1914	31.43	18.86	29.15	23.13	21.13	30.80
1915	34.81	18.36	38.66	22.61	16.97	61.59
1916	50.75	24.53	40.58	25.50	17.84	100.15
1917	105.47	49.83	56.62	40.84	34.09	179.51
1918	113.32	63.31	83.06	44.04	40.64	133.14
Total farm values:						
1911	443,984.00	244,905.00	92,276.00	11,180.00	25,775.00	3,000.00
1912	497,012.85	270,780.00	81,418.00	23,529.00	41,517.00	1,160.00
1913	610,228.00	287,195.00	126,450.00	57,740.00	30,131.00	4,123.00
1914	709,409.00	196,716.00	159,806.00	70,915.00	41,373.00	78,399.00
1915	873,721.00	173,297.00	249,331.00	144,892.00	65,135.00	39,271.00
1916	1,435,403.00	266,898.00	328,725.00	124,915.00	29,465.00	467,697.00
1917	3,752,669.00	642,870.00	262,928.00	281,120.00	30,680.00	2,280,823.00
1918	5,105,132.00	565,322.00	380,216.00	181,361.00	35,956.00	3,159,634.00

[a] Farm value per acre and total farm value of cotton include both fiber and seed.
[b] This area is included in the alfalfa-hay acreage for 1911.

MISCELLANEOUS CROPS.

The pasture land listed in Table III is composed mostly of alfalfa, or of old alfalfa fields badly infested with Bermuda grass. Two

other field crops, broom corn and beans, which have been of some importance during past years, were not grown extensively in 1918. Sweet sorghums and Sudan grass, along with wheat and barley hay, make up the total of 593 acres listed in Table III as hay other than alfalfa. A few farmers on the project have produced small areas of sugar cane to be utilized for sirup. On some of the most productive soils, this crop has given very satisfactory yields. Such a field is shown in figure 9. It has not been definitely determined as yet how many years a planting of sugar cane may be profitably maintained, but on the best soils the yields of the second and third years have been very good.

The production and value of the five principal money crops grown on the Yuma project in 1918 are compared in Table IV with similar statistics of these crops for the years 1911 to 1918, inclusive.

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FIG. 9.—A field of sugar cane growing on the Yuma Reclamation Project in 1918.

LIVE-STOCK INDUSTRIES.

There are no data available which will show the returns derived from live-stock industries on the Yuma project, but an inventory of live stock on the entire project on December 31 of each year from 1911 to 1918, inclusive, is shown in Table V. These figures do not indicate the extent of live-stock production for any year, but they do afford a comparison of the relative development of the different divisions of the industry from year to year.

This comparison shows a serious decrease of all meat-producing live stock except sheep, while the dairy-cattle population has decreased by 17.7 per cent in one year. This general decrease of live stock is no doubt due to the high value of feed during the past two years. Most dairy herds have been rigidly culled and re-

duced to smaller herds. The beef-cattle population shows a falling off of 67 per cent, while the number of hogs on the project was 70 per cent less at the end of 1918 than a year ago. While there was a smaller increase in the number of sheep on hand December 31, 1918, this still represents only a very small industry. All of these animals show a higher average value per head than a year ago.

TABLE V.—*Inventory of live stock on hand on the Yuma Reclamation Project at the close of each year for the 8-year period from 1911 to 1918, inclusive.*

Live stock.	1911	1912	1913	1914	1915	1916	1917	1918
Number:								
Horses	1,570	1,705	2,111	2,465	2,898	2,950	3,223	3,841
Mules	362	440	560	544	612	756	933	1,309
Beef cattle[1]	967	1,197	3,900	2,851	3,446	2,251	1,740	573
Dairy cattle				2,043	2,249	2,234	1,875	1,543
Sheep	.....	.....	.....	1,384	1,251	702	797	934
Hogs	1,767	2,634	2,836	4,982	12,500	13,688	8,136	2,421
Ostriches	40	121	184	193	121	91	70	50
Fowls	22,857	25,646	27,882	35,935	50,723	43,361	27,537	30,286
Bee colonies	2,433	2,542	2,712	4,062	2,480	4,569	2,104	4,178
Average value per head or unit:								
Horses	$106.00	$107.52	$105.00	$99.48	$90.20	$100.75	$103.43	$104.23
Mules	128.00	127.33	150.00	138.37	126.86	117.02	132.27	145.01
Beef cattle[1]	51.40	49.52	58.00	37.68	44.66	43.04	55.81	57.19
Dairy cattle				81.42	73.02	41.40	66.69	69.86
Sheep	.....	.....	.....	4.65	4.69	7.85	10.97	9.92
Hogs	7.15	9.07	8.65	7.60	6.49	7.90	10.42	15.09
Ostriches	315.00	186.95	145.00	5.57	5.83	17.69	50.00	10.00
Fowls	.64	.65	.62	.79	.65	.78	.94	.94
Bee colonies	3.15	3.21	4.00	4.80	4.84	3.40	6.83	7.50
Total value:								
Horses	166,389	183,364	221,525	245,227	261,410	295,245	333,351	400,367
Mules	46,340	56,030	84,329	75,272	77,640	88,470	123,417	189,825
Beef cattle[1]	49,705	59,270	224,251	107,434	153,906	96,873	96,981	32,772
Dairy cattle				166,335	164,235	159,505	125,055	107,800
Sheep	.....	.....	.....	6,432	5,868	5,513	8,740	9,265
Hogs	12,627	23,903	24,965	37,848	81,122	108,183	85,805	36,552
Ostriches	12,600	22,625	26,610	1,075	705	1,610	3,500	500
Fowls	14,559	16,578	17,180	28,342	32,936	33,923	25,702	29,456
Bee colonies	7,674	8,159	10,832	19,499	12,002	15,565	13,370	32,400
Total	309,934	369,929	609,692	687,484	789,824	804,887	815,921	838,937

[1] Beef and dairy cattle for 1911, 1912, and 1913 were not segregated.

During the past year there is shown an increase of nearly 1,000 horses and mules. This seems to be only a normal increase of work stock to care for the increased area of land under cultivation. The figures for 1917 show one work animal for 8½ acres farmed, while the census for 1918 shows an average of one work animal for every 8¾ acres farmed.

The poultry industry on the project experienced a sharp decline in 1917, which was partly regained in 1918. The number of fowls on hand at the close of the past year was 30,286 as compared to 27,537 twelve months earlier, but this number is still 30 per cent lower than the total on hand at the close of 1916. The values of the various fowls remain about the same as a year ago. The ostrich industry has not yet returned to a profitable basis. A few ostriches on the project were killed because they were not considered worth the feed they required for maintenance.

The number of bee colonies on hand shows an increase over a year ago of 2,074. There was a continuing good demand for honey, but the production of the year evidenced the reduction of bee pastures, which coincided with the reduction of alfalfa acreage.

DISEASES AND PESTS.

Animal diseases.—There was apparently no important loss of live stock on the project during the year from contagious diseases. Such diseases as have occurred in the past have been mentioned in reports of this station for 1916 and 1917.

Plant diseases.—Very few plant diseases have yet been recognized as seriously detrimental on the Yuma project. Project conditions in this regard have changed very little from those discussed in the report of this station for 1917. In addition to those diseases named, mention should be made of angular leaf-spot of cotton, which has been found in some fields but never in such abundance as to cause serious loss.

Insect pests.—Nearly all economic plants, except cotton, passed through the last year with a minimum amount of insect damage. The mild winter temperatures which were experienced seem to have provided very desirable conditions for the early propagation of insects detrimental to cotton. Climatic conditions that followed later were also favorable to insect life and as a result the crop loss was greater than in past years. The first pest that became generally detrimental was the cotton aphis, which in some fields was found in great numbers until late in July. This is the only year since 1914 that such an unusual abundance of these insects continued into the hot summer. This survival is believed to have been due in part to a period of cool nights, which is an unusual condition to obtain at that season. Some of the cotton growers of the largest acreages attempted to perfect a power sprayer and apply a spray of blackleaf-forty, but had only begun operations when hot, dry weather followed, which apparently provided the parasites of this insect the desirable conditions needed to effect a natural control. In some fields a serious loss from this pest was experienced through a heavy shedding of squares.

The pest that curtailed cotton yields more than any other during the year was the cotton bollworm,[1] which was in greatest abundance during July and early August. In some fields it was estimated that yields were reduced as much as 70 per cent. The second most important loss to the cotton grower from insect depredation was committed by plant bugs. This group of insects includes several species that were present which are known to feed on the cotton squares and bolls. Those that seemed to be most abundant were

[1] This should not be confused with the pink bollworm, a serious cotton pest not yet found on the Yuma project.

three species of large stinkbugs and the tarnished plant bug. The sharpshooter was found to be present, but not in abundance, and it is doubtful whether any injury to the cotton plant was perpetrated by this insect. The plant bugs were in greatest abundance during late September and through October. These bugs attacked the tender squares or bolls, and although few bolls of medium size or larger were caused to drop, there were many squares and newly formed bolls which shed after being punctured. This is no doubt the most serious damage to the crop, but the more noticeable injury is observed in the mature cotton boll. The injury from these insects as recognized in the mature cotton boll is the presence of hollow seed surrounded by brown-stained fiber which is of inferior strength. In the ginned fiber these spots are noticeable as coarse brown-colored particles which, if sufficiently abundant, reduce the grade and value of the fiber. These same insects commonly attack various weeds and particularly sorghum heads before the seeds are hard. The most satisfactory control of these plant bugs as yet recognized is the thorough cleaning up and burning of all rubbish, brush, or grass that is near a cultivated field, as these insects pass the winter by hibernating in such material.

Other insects which are injurious to cotton, but at this time are of minor importance on the project, are cutworms (*Peridroma* sp.), wireworms (*Monocrepidius* sp.), the cotton leaf-perforator (*Bucculatrix thurberiella* Busck), the salt-marsh caterpillar (*Estigmene acraea* Drury), the red spider (*Tetranychus bimaculatus* Harvey), and grasshoppers.

Insect pests that sometimes injure crop plants in this region, but which were not seriously abundant this year are the alfalfa butterfly, alfalfa-seed chalcis fly, spring grain-aphis, and grasshoppers; also the red spider and plant lice, which damage garden plants and ornamentals.

Ants are very frequently a serious pest of field crops and also very troublesome about farmsteads on the Yuma project. Some colonies may easily be exterminated, but other species of wandering habits are more difficult to deal with. The most effective means of control yet found has been the fumigation of the den with carbon disulphid or the distribution of London purple around the entrance of the den.

Bird and animal pests.—No unusual loss was experienced by the farmer in 1918 by the destruction of crops by birds or animals. Such damage as commonly occurs is the loss of grain sorghums eaten by Mexican doves, the injury to field crops by gophers and rabbits, the damage to irrigation ditches by gophers, and the loss of poultry occasioned by predatory animals, such as foxes, bobcats, and coyotes.

Weeds.—Obnoxious plants which are indigenous to this region or which have since become established as weeds have been discussed in recent reports of this station. These various weeds, listed

in their probable detrimental importance as they must now be encountered by the farmer, are Bermuda grass (*Cynodon dactylon*), sour clover (*Medicago indica*), Johnson grass (*Holcus halepensis*), sand bur (*Cenchrus* sp.), water grass (*Leptochloa* sp.), cocklebur (*Xanthium* sp.), and ground-bur nut (*Tribulus terrestris*). There are, of course, many other weeds that flourish here when afforded an opportunity but which are of minor importance because of the relative ease by which they may be controlled by good farming methods.

ECONOMIC CONDITIONS.

The good prices received for all farm crops during the past two years and the ample supply of water always available for lands under the Yuma project have probably been the most important factors to stimulate land values. Much land has been bought and sold in both the lower Yuma Valley and the Bard units of the project, and rents have increased in value very materially. In 1917 the average price per acre of unimproved land on the Yuma project without paid-up water rights was about $75, while in 1918 it was about $150. The average price in 1917 for the same land improved was about $130 per acre, but in 1918 it was about $250 per acre. Improved land with a paid-up water right was valued in 1918 at about $325 per acre.

Building conditions.—Probably owing to war regulations governing building material, the commercial development of the project did not keep pace with agricultural development. However, many new business enterprises were established in the different towns of the project, especially at Somerton, which is located in the center of the Yuma Valley and is connected with Yuma by a paved highway.

Three new cotton gins were built on the project during the year, while another gin already in operation was doubled in capacity. Even these gins did not afford ample service for the cotton growers, as long trains of wagons of seed cotton awaited their turns at nearly every gin during the main ginning season. Figure 10 pictures such a condition at one of the local gins in the lower Yuma Valley.

Labor.—Farm labor was unusually scarce during the busiest months of the year but not critically so at any time. The importation of Mexican labor for chopping and picking cotton relieved this situation greatly. It was largely through the aid of the local office of the Federal Employment Bureau that these labor problems were alleviated.

Farmers' organizations.—The farmers' organization by far the most important and influential on the project is the Yuma County Water Users' Association, which has a membership of about 950 and represents approximately 57,790 acres of irrigable land. While this association deals primarily with matters of water rights and water

distribution, it gives some attention to other matters of direct interest to the water user. The officers of this organization consist of a president, vice president, board of governors of six, and a council of 12 elected by the members to serve for a term of one year.

The only other active farmers' organization of importance is the Yuma County Farm Bureau.

THE YUMA EXPERIMENT FARM.

The work of the Yuma Experiment Farm is directed chiefly toward the solution of local problems of crop production. Most of the crops being grown are those which are already of commercial importance on the Yuma Reclamation Project and other

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FIG. 10.—Cotton wagons awaiting their turn at a gin on the Yuma Reclamation Project in 1918.

irrigated areas along the lower Colorado River. The experiment farm is located 7 miles northeast of Yuma, Ariz., on that area of the Yuma project known as the Bard unit. This station began operation in 1910 on a tract of 160 acres of raw land, all of which is irrigable. At the close of 1918 the entire farm, except about 15 acres, was being irrigated and cropped. The farm is in charge of the Office of Western Irrigation Agriculture of the Bureau of Plant Industry, while facilities are provided for some special experiments conducted by other offices of the Department of Agriculture.

In this circular it is intended to give the results of such experiments as are sufficiently complete to be of value to local farmers and also to report the progress of incomplete tests which may be of present interest.

During 1918, 194 additional varieties and species of plants were added to those already being tested. Figure 11 shows a diagram of the fields and the location of the experiments which were conducted on this station during 1918.

CROP EXPERIMENTS.

Crop experiments in 1918 were conducted along nearly the same lines as in past seasons. Those which seemed to be of most interest

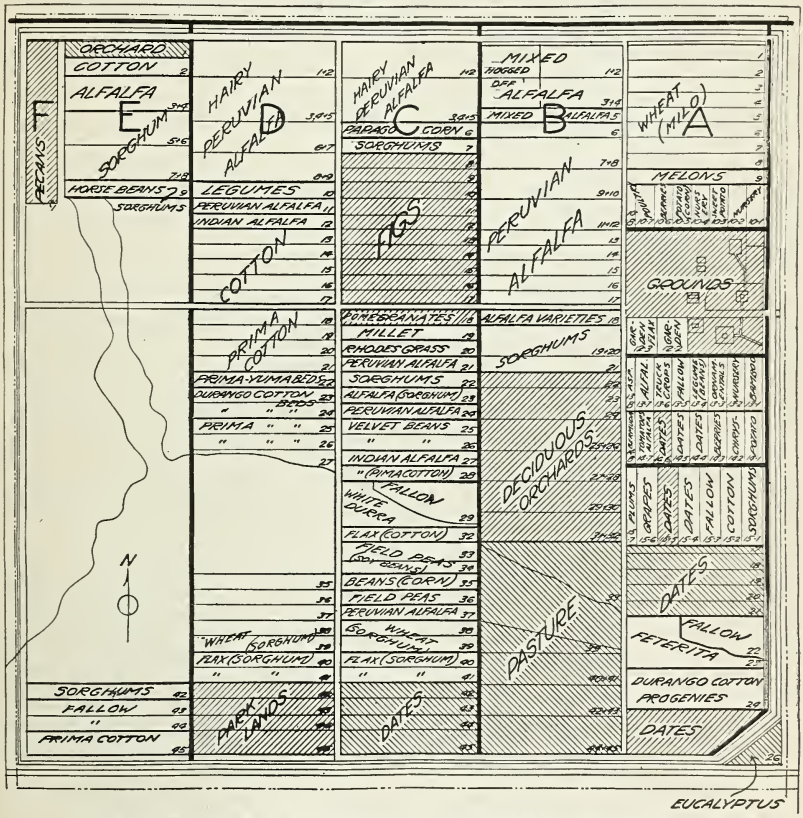

FIG. 11.—Diagram showing the arrangement of the fields and the location of the experiments at the Yuma Experiment Farm in 1918.

to the farmers of this region were the cultural experiments with cotton of both the Egyptian and the Upland types.

The principal experiments under way are (1) cultural and varietal tests of cotton; (2) the breeding of Durango, Kekchi, and Tuxtla cottons; (3) the testing of alfalfa varieties; (4) the pasturing of alfalfa by hogs; (5) the testing of miscellaneous forage crops; (6) varietal and cultural tests of flax for seed production; (7) the testing of various grain-sorghum varieties on two types of soil; (8) tests of many varieties of deciduous fruits and grapes; (9) fruiting tests

of various small fruits; (10) the fruiting of collections of seedling dates, figs, and pomegranates; (11) the culture of truck crops; and (12) the testing of various ornamental trees and shrubs.

COTTON.

VARIETY TESTS AND RATOONING.

Most of the varieties included in tests at this station during 1916 and 1917 were again grown in a comparable test in 1918. Along with this list of variety plantings, a ratooned block of varieties was also carried through from the previous year. This block consisted of the same plats from which yields are reported for 1917, which affords a direct comparison between these yields and the yields from ratooned varieties in 1918. The field where the 1918 seeded plantings were made adjoins the ratooned field and the soil is very similar. The yields of these varieties in the different tests and their rank with other varieties of the same type of cotton are shown in Table VI.

The varieties included in Table VI were all grown on plats of small area, but they furnish a useful comparison of the development of these different cottons under local conditions. The outside rows on each block were planted to Durango cotton and are not included in the computed yields in this table. These varieties were all planted on April 3 and thinned on May 22, when about 8 inches high. This planting date was favorable for all Upland cottons, but it was too late to obtain maximum yields from the Egyptian and Sea Island varieties.

It has been known for many years that plants of most cotton varieties can be grown in this climate for more than one year by ratooning fields of the previous year, but no observations have heretofore been recorded regarding the relative behavior of different varieties when ratooned. Large areas of Upland cotton have been ratooned in past years, both in the Imperial Valley and on the Yuma project, from which yields have often been satisfactory; but other conditions of cultivation and harvesting have been sufficiently adverse to cause most farmers to abandon the practice except under some unusual circumstances. In this test a great difference of hardiness was indicated among the different varieties, the number of plants remaining alive through the winter varying from 34.7 to 85.4 per cent. The Yuma variety of Egyptian cotton seems to be particularly hardy. In a previous test a high percentage of the original plants of this variety was brought through three successive winters.

In a comparison of the yields of the 28 varieties ratooned in 1918 with yields of the original plantings of the previous year, it is seen that 13 varieties produced a greater yield when ratooned, while the

production of the remaining 15 varieties declined. If a similar comparison is made between the yields of varieties ratooned in 1918 and the same varieties seeded in 1918, it will be seen that out of a total of 24 varieties seeded in 1918, 12 show an increase and an equal number show a decrease.

TABLE VI.—*Yield of cotton grown on the Yuma Experiment Farm in 1916, 1917, and 1918, compared with the yields in 1918 of ratooned plats.*

Variety.	Yield of seed cotton per acre (pounds).				Rank.				Percentage of plants successfully ratooned in 1918.
	Planted in —			Ratooned in 1918.	Planted in—			Ratooned in 1918.	
	1916	1917	1918		1916	1917	1918		
Long staple (fiber $1\frac{7}{16}$ to $1\frac{5}{8}$ inches):									
Pima	.....	2,184	1,442	748	.....	1	4	4	39.6
Yuma	[a] 685	2,169	2,048	2,384	3	2	1	1	85.4
Gila	.....	.....	1,769	.....	.....	.....	2	.....	.....
Meade	[a] 981	1,422	1,092	1,669	2	3	5	3	69.8
Snowflake	1,007	1,422	1,674	2,098	1	4	3	2	70.7
Sea Island	[a] 105	119	414	342	4	5	6	5	35.8
Long-staple Upland (fiber $1\frac{3}{16}$ to $1\frac{5}{16}$ inches):									
Durango (select strain)	.....	2,022	1,719	2,064	.....	1	3	2	60.0
Durango (commercial)	1,761	1,654	.....	1,547	1	6	.....	5	63.2
Number 18	.....	1,913	1,761	1,387	.....	2	2	6	47.7
Foster	1,109	1,787	1,341	914	4	3	4	8	34.7
Columbia	1,290	1,767	2,821	1,709	3	4	1	4	41.7
Kekchi	917	1,251	1,077	1,267	5	7	6	7	64.2
Lewis	1,390	1,668	.....	1,955	2	5	.....	3	73.9
Mixson	.....	1,227	1,135	2,406	.....	8	5	1	56.8
Short staple (fiber 1 inch to $1\frac{1}{8}$ inches):									
Acala	2,620	1,808	1,936	1,777	1	2	2	3	55.8
Express	1,263	1,907	.....	1,716	6	1	.....	4	76.0
Tuxtla (early)	.....	1,726	1,479	2,056	.....	3	5	2	76.9
Tuxtla (late)	1,756	1,028	1,365	1,147	3	8	6	7	45.3
Triumph (Mebane)	1,513	1,361	1,165	1,326	5	5	7	6	63.7
Keenan	477	1,375	.....	2,210	8	4	.....	1	35.8
No. 624	1,755	1,222	1,158	1,542	4	7	8	5	56.6
Holdon	1,784	1,214	1,866	964	2	6	3	8	36.4
Lone Star	1,216	.....	[b] 918	.....	7	.....	9	.....	55.6
Askew Big Boll	.....	.....	1,846	.....	.....	.....	4	.....	.....
Rowden	.....	.....	2,104	.....	.....	.....	1	.....	.....
Short staple (fiber 1 inch or less):									
Dixie	2,296	2,620	1,911	2,213	1	1	1	2	67.7
King	1,809	1,997	1,356	964	4	2	6	7	57.6
Ideal	1,701	1,851	1,576	1,172	5	3	4	6	66.7
Trice	1,593	1,794	1,401	1,241	6	4	5	5	81.8
Cleveland	2,079	1,769	1,401	1,295	2	5	5	4	45.9
Half-and-Half	1,972	1,707	1,706	1,812	3	6	3	3	76.8
Sproull	.....	1,634	1,896	2,558	.....	7	2	1	53.9

[a] Planted too late for yield to be comparable with other varieties in the test during 1916.
[b] Planted too late for yield to be comparable with other varieties in the test during 1918.

The average yields of seed cotton per acre of these 24 varieties under different tests were (1) seeded in 1917, 1,626 pounds; (2) ratooned in 1918, 1,543 pounds; and (3) seeded in 1918, 1,531 pounds. In a comparison of the lint percentages of cotton produced from each of these varieties when seeded and when ratooned, no consistent difference was apparent.

Five of the most promising varieties of Upland cotton were grown in much larger plats in another field, which produced yields as shown in Table VII.

TABLE VII.—*Yields under different methods of thinning of five well-adapted Upland cotton varieties grown on the Yuma Experiment Farm in 1918, compared with 1917.*

[No yields of outside rows have been included in this table, as these are always greater than yields from the interior rows of an irrigated block.]

Thinning distance (rows 42 inches apart).	Number of—		Average yield of seed cotton per acre (pounds).							
	Times thinned.	Plats of each variety.	Acala.	Durango.	Tuxtla.	Rowden.	Triumph (Mebane).	Average of each thinning.		
								1918	1917	Grand average.
Between plants:										
9 to 11 inches	2	2	1,555	1,117	1,259	1,698	1,551	1,374	2,119	1,747
13 to 15 inches	2	2	1,286	1,784	1,598	890	1,229	1,543	2,035	1,789
13 to 15 inches	1	2	806	1,249	1,029	1,274	872	1,058	1,938	1,498
17 to 19 inches	1	2	1,467	2,044	1,664	1,713	1,535	1,690	1,874	1,782
Average yield of variety:										
In 1918	.....	.....	1,279	1,549	1,388	1,608	1,297	.....	.....	.....
In 1917	.....	.....	2,032	2,025	1,918	.....	.....	.....	.....	.....

THINNING TESTS.

In order to repeat the thinning experiment as conducted with the most promising varieties of Upland cotton in 1917, the varieties in the test just described were thinned by four different methods. A comparison of the results obtained with those of 1917 is also shown in Table VII. It will be observed from these data that the results of the 1917 test were not confirmed by the 1918 test. It is the writer's belief, however, that the local conditions of 1917 for Upland cotton were more nearly normal than those of the present year. These plats were planted on April 4. All varieties were thinned first on May 23, and on June 28 a second thinning was made on those plats that were to be thinned twice. As already stated in this report, the climatic conditions during the growing season were not the most desirable for Upland cotton, and during August an abnormal amount of shedding of squares and small bolls was experienced. The damage from cotton stainers on this block was also quite severe. Nearly all cotton in this test was sufficiently mature by the time of the first killing frost on November 6 to escape serious damage. The crop was harvested in two pickings on September 30 and December 7.

TIME-OF-PLANTING EXPERIMENT WITH PIMA COTTON.

The farmer is often confronted in the spring with a problem of when is the most desirable date to plant cotton and, in some instances, as to how late in the season land may profitably be planted to cotton. These dates are quite well determined by past experiments in regard to Upland cotton, but few definite data have been at hand to support the accepted optimum planting dates for Egyptian cotton.

During this season, a test was planned which provided for a planting of Pima cotton made at regular intervals of 7 days, extending from March 9 to May 11. Quarter-acre plats were utilized on medium light soil which was quite uniform. The plats of this area were thought to be of sufficient size to eliminate the factor of spottedness of soil that often affects the results of yields from small plats on this land. All plats were planted after the soil had been well irrigated and a good seed bed formed. Such culture as seemed to be required was given each plat at all times and was, in the main, nearly identical for all plats.

The earlier plantings were thinned at an average period of about 51 days after planting. The intermediate plantings were thinned about 43 days following planting, and the later plantings, which made a more rapid seedling growth, were thinned about 38 days after planting. All plats were thinned at an average space between plants in the rows of about 18 inches. The original stand of each plat was fairly good and afforded an opportunity to have good stands after thinning. The cotton was picked and weighed by individual rows, in order that the outside rows might be eliminated in comparing yields. In Table VIII are expressed the relative yields, computed in pounds of seed cotton per acre.

TABLE VIII.—*Time-of-planting test of Pima cotton on the Yuma Experiment Farm in 1918.*

Date of planting.	Number of days before killing frost.	Date of picking.			Yield per acre of seed cotton (pounds)		Rank of yield.
		First.	Second.	Third.	Average of plat.	Decrease from previous planting	
March 9	242	Sept. 15	Oct. 15	Dec. 16	1,472	.....	2
March 16	235	...do.....	...do.....	...do.....	1,593	.....	1
March 23	228	Oct. 20	Dec. 15	.....	1,455	138	3
March 30	221	...do.....	...do.....	.....	1,410	45	4
April 6	214	Oct. 25	...do.....	.....	1,385	25	5
April 13	207	...do.....	...do.....	.....	1,289	96	6
April 20	200	Oct. 28	...do.....	.....	1,248	41	7
April 27	193	...do.....	...do.....	.....	1,216	32	8
May 4	186	Nov. 12	Dec. 16	.....	1,211	5	9
May 11	179	...do.....	...d o....	.....	1,203	8	10

It will be observed from Table VIII that the greatest yield was from the plat planted on March 16. The next best yields were from those plats planted one week earlier and one and two weeks later. This experiment should be repeated another year and also compared with results of similar tests from other stations where this variety of cotton is grown, as the first killing frost in the autumn was abnormally early this season. Two such tests with Upland cotton in past years have indicated that the best yields of cotton of this type will generally be secured from plantings made during the first three weeks of

April. Occasionally, March or even February plantings will produce equal or greater yields, but the hazard of encountering a period of cold nights which may cause poor stands is ordinarily sufficient to discourage such a practice. The question of how late in the season profitable plantings of Upland cotton may be made is often a pertinent one when small grains are to be followed by cotton. It was found in these tests that a crop of one bale an acre could be grown by good culture from plantings made the last of May.

THE FURROW-AND-BED METHOD.

The need of a method of planting and irrigating cotton by means of which excessive growth may be regulated on the most fertile lands in this region has been recognized for several years. Through a study of the causes that induce such growth, a possible method has been worked out which for convenience has been described as the furrow-and-bed method. This method of culture, which is still in the experimental stage, has been considered in detail in the reports of this station for 1916 and 1917. A further discussion of the method will, therefore, not be given here, but the results obtained from tests in 1918 and also of previous years are reported in Table IX.

TABLE IX.—*Comparative yields of the Pima and Durango varieties of cotton planted by the furrow-and-bed method and the ordinary method on the Yuma Experiment Farm in 1916, 1917, and 1918.*

Variety.	Method.	Years.	Distance between—		Date of planting.	Average yield per acre in pounds of seed cotton.
			Centers of furrows (feet).	Plants in the row (inches).		
Pima	Furrow and bed	1918	6	16.6	Mar. 18	1,597
Do	do	1918	7	16.1	do	1,577
Do	do	1918	8	17.2	do	1,347
Do	Ordinary	1918		18	Mar. 16	1,593
Do	Furrow and bed	1917	6	15	Mar. 15	1,853
Do	do	1917	7	15	do	1,823
Do	do	1917	8	15	do	1,753
Do	Ordinary	1917		15	Mar. 13	1,586
Durango	Furrow and bed	1918	8	18.8	Mar. 20	2,070
Do	do	1918	7	22.6	do	1,857
Do	do	1918	6	23.6	do	1,670
Do	Ordinary	1918		16	Apr. 4	1,549
Do[1]	Furrow and bed	1917	8.5	16	Apr. 13	1,846
Do	do	1917	7.4	16	do	1,741
Do	do	1917	6	16	do	1,628
Do	Ordinary	1917		16	Apr. 17	2,026
Do	Furrow and bed	1916	8.5	16	Apr. 24	1,610
Do	do	1916	7.5	16	do	1,760
Do	do	1916	7	16	do	1,840
Do	do	1916	6	16	do	1,450
Do	Ordinary	1916		16	Apr. 18	1,761

[1] The yields from the furrow-and-bed plantings of Durango cotton in 1917 are not true representative yields of this method, as the stand was very poor, being occasioned by planting on furrow edges which were too abrupt, allowing much seed to drop to the bottom of the furrow.

It will be observed from Table IX that in nearly all tests the plantings made by the furrow-and-bed method have produced somewhat

larger yields than ordinary plantings of the same variety. For the Pima variety, it seems that an interval of 6 feet between furrows is the most desirable arrangement to follow, while the furrows should be about 8 feet apart when Durango or any other vigorous-growing Upland cotton is to be produced. The yields in each test with Durango were smallest when the space between furrows was reduced to 6 feet. The pairs of rows are in each experiment 26 inches apart across the furrows. The land on the experiment farm where these tests have been made is not of the extremely fertile type where such a method would show the greatest value above the ordinary methods of field planting. However, even on this soil some advantages in yields are evidenced, although these are not deemed of sufficient importance to warrant advocating this practice on only moderately

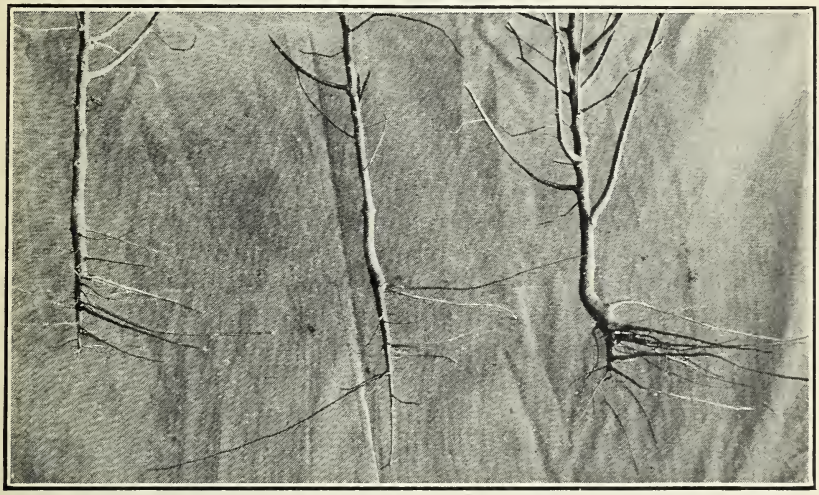

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FIG. 12.—Pima cotton plants grown by the furrow-and-bed method, showing one-sided root development.

productive soils. No general recommendation is made for commercial plantings, but it is thought that the trial of this method of growing both Pima and Upland cottons should be tested further on the most fertile soils of the Yuma project.

The probable reason that the excessive growth of the cotton plant can be retarded by this method of culture is that the feeding roots form on only one side of the plant. This fact is illustrated in figure 12. The plants for this photograph were not specially selected but are typical of the root development of all the cotton plants in the field.

BREEDING WORK.

Selection and breeding work with several varieties of Upland cotton has been in progress at this station for four years. The work

with the Tuxtla and Kekchi varieties has been conducted cooperatively with the Office of Cotton Breeding Investigations of this Bureau. Some very encouraging results are being obtained, especially with a strain of Upland cotton now being carried as No. 18. Several lots of this seed were distributed to cotton growers on the project for a comparison with the cottons that were then being grown commercially. Reports from such comparisons were all very favorable and warrant further trial of this selection.

ALFALFA.

The experimental planting of alfalfa grown during 1918 were nearly all continuations of tests of the previous one or two years. The results of hay production obtained confirmed those reported in 1916 and 1917. No additional data relating to problems of seed production were completed during this season.

The alfalfa situation on the Yuma project at the present date is briefly as follows: Three recognized varieties are being generally grown, namely, hairy-leaved Peruvian, smooth-leaved Peruvian, and Chilean (Arizona common or ordinary). A description of the history of the introduction of these varieties on the Yuma project was given in the report of this station for 1916. Various careful tests have shown that under comparable conditions these varieties rank in hay production in the order mentioned. Very small differences from the standpoint of seed production can be observed among these varieties. The prices received for seed are, however, much higher for hairy-leaved Peruvian than for other varieties, which factor, connected with the superiority of hay production of this variety, has made it the most profitable for the farmer on the Yuma project to grow. It is seed of this variety that is generally sought where alfalfa for hay production is seeded in other valleys of the Southwest. There is also a well-recognized market for Arizona common alfalfa seed, such as is produced on the Yuma project in regions farther east and north where Peruvian alfalfa is not hardy, and this seed should continue to be grown. The smooth-leaved Peruvian variety has always filled an intermediate place in both the alfalfa seed and hay industry on the project and has often been very confusing in the seed industry. It is well known that alfalfa plants cross-pollinate very readily, and the danger of gradual mixture both by cross-pollination and mixture in handling seed is much more serious where three varieties are being grown in an area than where only two exist. This condition is quite generally recognized by the farmer and seedsman, and it is to be desired that account will be taken of the opportunity to eliminate the smooth-leaved Peruvian variety in making future plantings. This opportunity will be presented in rather an exceptional degree to the

farmer, as much of the land now utilized in the present stimulated cotton production of the Yuma project will probably soon be seeded to other crops, mainly alfalfa.

Since it is known that some fields of alfalfa on the Yuma project have already become mixed, work has been started at this station to maintain seed of the best strain of hairy-leaved Peruvian alfalfa now being grown.[1] The results of this work should provide pure seed of this variety for further propagation. Rather extensive variety plantings of duplicate plats of an area of half an acre each were made late in this season with the following eight varieties: Hairy-leaved Peruvian, smooth-leaved Peruvian, Indian, Arizona common, Kansas common, Turkestan, Grimm, and Baltic.

GRAIN SORGHUMS.

VARIETY TEST.

More than 350 different strains and varieties of grain sorghums have been tested in various experimental plantings at this station during the past six years. Sufficient accurate information has been accumulated to determine the most promising varieties for this area, and during the past two years only those varieties have been grown in cultural tests along with recently introduced varieties. Such a variety test was conducted at this station in 1918 on light soil and on medium-heavy soil to compare both grain and forage production. The results of this test are given in Table X.

TABLE X.—*Comparative yields of grain-sorghum varieties grown on the Yuma Experiment Farm in 1918.*

Variety.	S. P. I. No.	Number of plats.		Relation of thrashed grain to air-dry heads (per cent).		Yield per acre.						Rank of averages of production.	
						Stover (tons).			Thrashed grain (bushels).				
		Medium-heavy soil.	Light soil.	Medium-heavy soil.	Light soil.	Medium-heavy soil.	Light soil.	Average.	Medium-heavy soil.	Light soil.	Average.	Stover.	Grain.
Dwarf milo [1]	.....	2	2	78.6	78.3	3.64	2.17	2.91	44.0	29.2	36.6	4	2
Feterita	19517	2	2	78.6	79.3	2.82	2.04	2.43	30.0	24.3	27.2	6	7
Do.[a]	.....	2	2	78.0	78.0	2.51	1.79	2.15	33.1	23.9	28.5	7	6
Dwarf Blackhull kafir	22653	2	2	78.1	76.8	4.13	2.22	3.18	34.1	25.5	29.8	3	5
White durra [b]	.....	2	2	.....	55.8	5.09	4.33	4.71	.....	14.0	.....	1	.....
Dwarf hegari	.....	2	2	84.9	82.9	4.19	1.97	3.33	46.7	28.2	37.5	2	1
Brown kaoliang	38463	2	2	79.9	80.8	2.16	1.78	1.97	33.9	31.2	32.6	8	4
Dwarf brown kaoliang (F. C. I. No. 9422)	.....	2	2	75.3	72.7	1.06	.92	.99	15.4	17.1	16.3	9	8
Dwarf brown kaoliang	38199	1	.....	85.5	.....	2.07	.....	.....	42.2	.....	.....	.....	.....
Brown kaoliang	24990	1	.....	80.8	.....	1.94	.....	.....	39.5	.....	.....	.....	.....
A milo hybrid	.....	2	2	67.6	63.9	3.90	1.53	2.72	39.3	26.4	32.9	5	3

[a] Yuma Experiment Farm selected seed.

[b] The plats of White durra on the medium-heavy soil were killed by frost before the grain was mature.

[1] This work is in cooperation with the Office of Forage-Crop Investigations of the Bureau of Plant Industry.

The area of the plats included in this test ranged from about one-tenth to one-eighth of an acre. The rows were 42 inches apart and the plants were thinned to a space of about 12 inches apart in the row. The stands were good, on the light soil averaging about 96 per cent perfect and on the medium-heavy soil about 88 per cent perfect. On the light soil these varieties were planted on July 12, and all were harvested by November 7. The plantings on the heavier soil were made two days later but were not all ready for harvest until November 19. Of course, most of the varieties in this test were mature before the final dates, as given, but the varieties requiring the longest season were not. The plantings on the light soil matured at least ten days earlier than the same varieties on medium-heavy soil. The White durra variety, which requires the longest season, did not ma-

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FIG. 13.—A field of Dwarf hegari growing on the Yuma Experiment Farm in 1918.

ture any grain on the heavy soil, as the plants were all killed by the frost which occurred on November 6.

It will be observed from Table X that only one variety in this test (Dwarf hegari) produced more grain than Dwarf milo, which is the standard variety of grain sorghum for this region. Dwarf hegari also matured a heavy yield of grain in the tests of 1917 and this variety ranks second in the growth of forage. The plant is relatively short but very leafy, with a thick stalk, making it a desirable variety for feed for live stock as fodder in bundles. This variety is very uniform in growth, as is shown in figure 13. The percentage of thrashed grain from air-dry head weights is among the highest of the varieties in this test and ranges about 5 per cent higher than either Dwarf milo or feterita.

Among the four strains of brown kaoliang grown there are three that may prove to be valuable in this locality. These varieties should be tested further. All are light forage producers, but they mature a grain crop in a little shorter season than most other varieties and, if planted in April, will produce two crops of grain in one season. When this practice is followed the stalks are cut about 4 inches above the surface of the ground and are removed from the field when the first grain crop is mature. The field is then irrigated at once, forcing a second growth of stalks from the same roots. Two of these strains have glumes that are abundantly covered with small hairs. In some regions this character contributes toward the collection of much fine dust in the grain head, which renders thrashing very disagreeable. Several other varieties were also tested this year on smaller plats, which are not reported in Table X. Sufficient study has not yet been made of these varieties to warrant a report at this time.

TABLE XI.—*Yields of seven valuable varieties of grain sorghums grown on medium-heavy and light soils on the Yuma Experiment Farm during the 6-year period from 1913 to 1918.*

[The statement of yields is in bushels per acre.]

Variety.	Type of soil.[1]	Month when planted.										Variety average.		Rank of varieties.	
		March.		April.		May.		June.		July.					
		Number of plantings.	Yield.	Number of plantings.	Yield.	Number of plantings.	Yield.	Number of plantings.	Yield.	Number of plantings.	Yield.	Number of plantings.	Yield.	On medium-heavy soil.	On light soil.
Dwarf milo	Mh	1	32.0	2	17.9	2	44.3	1	36.8	3	31.8	9	32.6	3	....
Do	L	....	....	....	....	....	....	4	31.6	2	21.4	6	26.5	....	3
Feterita	Mh	1	49.6	2	38.7	1	37.4	1	40.3	2	25.7	7	38.3	2	....
Do	L	....	....	....	....	1	42.0	5	29.3	2	21.8	8	31.0	....	1
Dwarf hegari	Mh	....	....	....	....	....	....	1	46.7	1	46.7	2	46.7	1	....
Do	L	....	....	....	....	....	....	1	29.8	1	28.2	2	29.0	....	2
Dwarf Blackhull kafir	Mh	1	17.7	2	10.8	1	24.0	1	20.8	2	24.9	7	19.6	6	....
Do	L	....	....	....	....	1	16.9	3	21.4	2	24.0	6	20.8	....	6
Brown kaoliang	Mh	1	19.8	2	11.8	1	21.0	....	....	3	27.2	7	20.0	5	....
Do	L	....	....	....	....	1	22.0	3	25.0	3	22.3	7	23.1	....	5
White durra	L	....	....	....	....	....	....	1	37.5	1	14.0	2	25.7	....	4
Shrock kafir	Mh	....	....	....	....	....	....	2	24.8	....	....	2	24.8	4	....
Average	....	....	29.8	....	19.8	....	29.7	....	31.3	....	26.2	....	....	....	....

[1] Abbreviations: Mh=medium-heavy soil; L=light soil.

The grain yields of the varieties of grain sorghums that have been found to be most valuable in this region and which have been obtained from various plantings at this station from 1913 to 1918, inclusive, are listed in Table XI. Some of the best yields from the April and May plantings represent two grain crops harvested from the same plants in one season. This practice is, however, not generally followed, as the crop that is matured early in the season is very frequently nearly all lost by bird injury before being ready to

harvest. The July plantings listed in this table all represent those made early in the month. Either late June or early July plantings are generally most profitable. Occasionally, late July or early August plantings will mature very good yields of grain, but there is always the hazard that such late crops may be lost by the occurrence of an early autumn frost. From 90 to 110 days of good growing temperatures are required for the development of grain of all the varieties included in this table except the kafirs and White durra, which require from 10 to 20 days additional.

SPACING TEST.

Dwarf hegari is relatively a new variety and has not been grown extensively under irrigation. In an effort to acquire definite information regarding the best planting method to follow with this variety a distance-of-spacing experiment was conducted this season. Duplicate plats of about one-eighth of an acre in area were planted in rows 42 inches apart on July 11. The plants in each plat were thinned on August 21 to regular intervals in the row, with the results shown in Table XII.

TABLE XII.—*Results obtained in spacing tests of Dwarf hegari grown on the Yuma Experiment Farm in 1918.*

Spacing.		Dates.			Number of plats.	Yield of thrashed grain.	
Between plants in the row.	Between rows.	Planted.	Thinned.	Harvested.		Per acre.	Relation to air-dry heads.
	Inches.					*Bushels.*	*Per cent.*
6 to 8 inches	42	July 11	Aug. 21	Nov. 25	2	36.12	84.8
12 to 14 inches	42	...do	...do	...do	2	27.45	82.4
22 to 26 inches	42	...do	...do	...do	1	29.50	83.5
Average						31.02	83.6

The comparison of these varied thinnings shows a distinct advantage gained by close spacing. In several similar tests of previous years in growing the Dwarf milo variety, the optimum spacing was determined to be about 12 inches between plants in the rows.

SEED PRODUCTION.

During the summer of 1918 this station distributed to 88 farmers on the project enough seed of a very good strain of Dwarf milo for each to plant from 1 to 3 acres. This strain had been carefully grown and selected under local conditions for four years and seemed to be superior to most grain sorghum that was being produced on the project. After the grain from these plantings was harvested, a

questionnaire was sent to each farmer asking for a comparison of the performance of this grain sorghum with other strains that were planted and for the details of culture followed. Only 28 of these cards were returned, and from these the following information was compiled: All reports showed this strain to be equal to other seed that was planted, and in many cases it was found to be from 20 to 50 per cent superior. The soil on which the grain was grown varied from sandy to heavy clay and adobe. The space between rows varied from 30 to 48 inches, while the distance between plants ranged from 6 to 36 inches. The best yields were reported from rows about 3 feet apart, with plants at a frequency of 14 to 24 inches apart in the row. The average planting date of fields producing good yields was from June 20 to July 15. A few plats were planted as late as August 10; but none of these matured grain, as they were killed by frost early in November. The average of yields reported was 2.03 tons of head grain per acre, which is equivalent to 55.1 bushels of thrashed grain.

FLAX.

Several of the cultural experiments with flax which have been conducted during the past few years were repeated in 1918 and have supplied information on certain phases of the possibility of flaxseed production in this area that seems dependable. Flax has not yet been grown as a commercial crop in this region, but may become a profitable crop under certain limited conditions. The first attempt to grow flax at this station was in May, 1914, when 14 varieties were seeded in rows, but the test gave only discouraging results. As it was evident that this crop would not develop normally during the season of high temperatures, further seedings were made during the following autumn and winter with much more promising results. Since this first attempt, various cultural and varietal tests have been conducted on large plats for the past three years. Much of the information accumulated has already been recorded in the last two yearly reports of this station. This crop has not been grown with a view to fiber production, but only for seed.

VARIETY TEST.

A series of 19 varieties of flax has been grown in nursery rows for study and comparison for the past two years, and most of these varieties have been grown for three years. The yields of these tests are reported in Table XIII.

These yields, of course, are not directly comparable to those from larger areas but have afforded useful data as to the relative value of varieties. The planting in 1916 was in rows 18 inches apart; in 1917, 30 inches apart, while in 1918 the rows were 20 inches apart. This

variation in row spacing to some extent accounts for the variable yields from year to year of each variety. In 1918 the variety rows were from 26 to 40 rods long, giving greater areas than similar tests of the previous years.

TABLE XIII.—*Seed yields of varieties of flax tested on the Yuma Experiment Farm in 1916, 1917, and 1918.*

Variety number.[1]	Yield per acre (bushels).				Variety number.[1]	Yield per acre (bushels).			
	1916	1917	1918	Average for 1917 and 1918.		1916	1917	1918	Average for 1917 and 1918.
No. 30	17.0	19.5	19.2	19.8	No. 3	11.7	11.7	11.5	11.6
No. 102	.....	17.1	18.5	17.8	No. 35	26.2	12.5	10.6	11.6
No. 151	.....	15.6	19.7	17.7	No. 16	44.8	10.5	12.5	11.5
No. 20	.....	15.2	17.6	16.4	No. 2	20.0	11.7	10.8	11.3
No. 149	.....	18.7	14.1	16.4	No. 152	.....	17.9	11.4	11.3
No. 148	.....	19.9	12.7	16.3	No. 147	.....	12.9	9.6	11.3
No. 150	.....	13.3	17.6	15.5	No. 38	64.0	9.3	10.1	9.7
No. 25	19.2	13.6	15.9	14.8	No. 4	18.1	10.2	8.8	9.5
No. 27	18.3	15.6	12.5	14.1	No. 13	13.5	7.8	8.8	8.3
No. 26	20.6	14.4	13.3	13.9					

[1] All flax varieties have been carried under a series of numbers assigned by the Office of Cereal Investigations, in cooperation with which office these tests are conducted.

DATE-OF-SEEDING TEST.

In Table XIV are shown the yields that were obtained from a date-of-seeding test of the Damont variety (C. I. No. 3), compared with yields from similar tests of the same variety in 1917 and of the variety known as North Dakota Resistant No. 114 (C. I. No. 13) in 1916. The planting dates ranged in 15-day intervals from the last of November to the middle of February. The 1916 and 1917 plats were planted in rows 30 inches apart, while the 1918 plats were in rows 20 inches apart.

TABLE XIV.—*Seed yields of flax in date-of-seeding test on the Yuma Experiment Farm in 1916, 1917, and 1918.*

Date of seeding.	Yield per acre (bushels).				Date of seeding.	Yield per acre (bushels).			
	1916	1917	1918	3-year average.		1916	1917	1918	3-year average.
Nov. 25	6.0	14.8	.....	10.4	Jan. 15	7.4	23.5	14.0	15.0
Dec. 1	6.2	19.4	11.5	12.4	Feb. 1	5.4	23.5	12.0	13.6
Dec. 15	6 3	26.1	14.9	15.8	Feb. 15	.....	.....	3.11	3.11
Jan. 2	8.0	24.5	14.0	15.5					

These results are sufficiently uniform to indicate that only a slight variation in yield is to be expected from plantings made from December 15 to January 15, but the decline in yield is quite abrupt from plantings made later than the middle of January.

RATE-OF-SEEDING TEST.

The Damont variety (C. I. No. 3) was also grown in a rate-of-seeding broadcast test, the results of which are stated in Table XV, along with yields of a similar test with this variety in 1917.

TABLE XV.—*Seed yields of the Damont variety of flax in rate-of-seeding broadcast tests on the Yuma Experiment Farm in 1917 and 1918.*

Rate of seeding per acre.	Date seeded.		Date harvested.		Yields per acre.		2-year average (bushels).
	1917	1918	1917	1918	1917	1918	
18 pounds	Nov. 29	Nov. 28	May 17	May 9	8.98	8.21	8.59
25 pounds	do	do	do	do	10.05	11.75	10.90
30 pounds	do	do	do	do	10.76	13.63	12.20
40 pounds	do	do	do	do	10.90	15.06	12.98
50 pounds	do	do	do	do	10.85	13.24	12.05
60 pounds	do	do	do	do	10.66	11.80	11.23

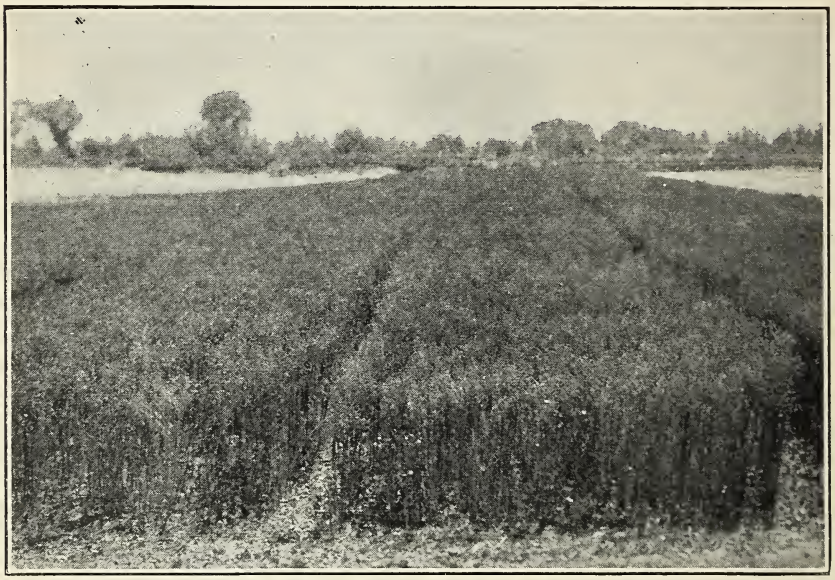
In various tests of broadcast seedings on the heavier types of soil the yields have not been equal to row plantings that were cultivated after each irrigation, but on lighter soils the yields from broadcast seedings have approached the yields of the row plantings much more closely. The expense of production is somewhat increased by the cost of cultivation; hence, on soils that do not bake and crack when drying, it may be more profitable to seed broadcast. Light sandy soils in this region do not produce profitable flaxseed yields. Table XV shows no marked differences among yields from seeding rates ranging from 30 to 50 pounds per acre, although in each test there was a slight decline in yield when more than 50 pounds of seed per acre were sown. From these data it would seem that when flax is sown broadcast for seed production, 30 to 40 pounds of seed per acre is the most desirable amount to use.

While it is not believed that a large industry of flaxseed production will ever become established on the Yuma project, it does seem probable that some farmers will find this a valuable crop to grow in certain rotations. The place in the rotation will be about the same as that now occupied by either wheat or barley, and flax may be found profitable to plant as a companion crop with late autumn or winter seeded alfalfa. Such a test has been planted on this farm for 1919 harvest. The flax will be mature for harvest during May and up until that time will probably not make sufficient shade to seriously retard the growth of the young alfalfa plants. A view of broadcasted plats of flax growing on the experiment farm is shown in figure 14.

In order to test the production of flaxseed more extensively, seed has been distributed from this station to several farmers on the Yuma project and other irrigated projects in this region under cooperative arrangements for 1919 production.

FIELD PEAS.[1]

To supplement variety tests of field peas that have been conducted at this station in previous seasons, 11 additional varieties were grown in 1918. This planting was made on November 24 in rows 3 feet apart, consisting of five varieties which were of Canadian origin, four from South America, and two from southern Europe. One plat of each of these varieties was harvested for a forage yield on April 25, and another plat for seed yield on May 25.



P6840W1

FIG. 14.—Broadcasted plats of flax growing on the Yuma Experiment Farm in 1918.

TABLE XVI.—*Seed and forage yields of field peas grown on the Yuma Experiment Farm in 1918.*

Name of variety.	S. P. I. No.	Introduced from—	Yields per acre.		Comparable rank in production.	
			Seed (bushels).	Forage, green matter (tons).	Seed.	Forage.
Andes	23848	South America	3.1	4.72	7	1
Multipliers	22637	Canada	5.3	3.85	3	2
Peluschka	22079	do	1.3	3.73	10	3
Victoria	22048	do	2.5	3.51	8	4
Vida	23851	South America	3.17	3.43	6	5
Lima	23850	do	6.0	3.37	2	6
Clamart	22638	Canada	4.1	3.17	4	7
Hubert	24893	Abyssinia	5.3	3.07	3	8
Fraile	24314	Spain	7.9	3.03	1	9
Prince	22046	Canada	3.8	2.99	5	10
—— (no name)	24262	South America	2.2	2.93	9	11

[1] These tests were made in cooperation with the Office of Forage-Crop Investigations of the Bureau of Plant Industry.

The yields from these varieties are listed in Table XVI. While a few of these varieties were sufficiently satisfactory for this region to justify further study, none of them seem to be superior to the varieties discussed in the 1917 report of this station.

A variety of Tangier pea introduced from Turkestan under S. P. I. No. 31,810 was also tested in comparison with these varieties of field peas. This plat produced at the rate of 4.44 tons of green material per acre and 1.13 bushels of seed per acre.

VELVET BEANS.

The Chinese velvet bean, previously grown here, has been found to produce a very large yield of green forage, but did not mature seed. Two of the shorter season varieties of velvet beans, Osceola and Georgia, were grown here this year. The former variety produced the heavier forage growth and was more vigorous throughout the whole season, but neither could be considered satisfactory. Both varieties were planted on May 22. The maximum forage production was reached in about 160 days. These plats were harvested on December 4 and gave the following yields of seed per acre: Osceola, 193 pounds; Georgia, 266 pounds.

HORSE BEANS.

Several varieties of horse beans have been tested during the past three years, but without encouraging results. It seems that this plant develops best when seeded in early November before the lowest temperatures of the winter occur. The principal growth is made in the early spring, but it does not approach the maximum development which is obtained where this legume is best adapted. A plat planted in November and harvested on May 10 produced a yield of 2.49 tons of green material per acre. The crops of seed produced have not been sufficient to compare favorably with field peas as a soiling or pasturing crop.

FORAGE SORGHUMS.[1]

A few recently introduced sorghum varieties were grown during 1918 in comparison with the best varieties known for this region. The following varieties are considered the best of those that are well known for feed or sirup production: Texas Seeded Ribbon, Honey, Gooseneck, White African, Orange, and Sumac.

Dwarf Java is a variety more recently known which gave indications from its first trials of being very desirable. It grows with comparatively short talks, averaging about 6 feet in height, uniform in growth, very leafy, and of medium fine stem. This variety produced 16.6 tons of green forage per acre and when left to mature seed gave

[1] This work, like much of that with other forage crops conducted this year, was carried on in cooperation with the Office of Forage-Crop Investigations.

a yield of 57.2 bushels per acre. The Collier variety has also proved to be very productive in this climate, but it does not mature a heavy crop of seed.

GIANT BERMUDA GRASS.

In the early spring of 1916, sod of Giant Bermuda Grass (*Cynodon dactylon maritimus*), from Mississippi, was supplied to this station by the Office of Forage-Crop Investigations and was planted and irrigated as a meadow during the following three years. The plat where this planting was made was slightly infested with the common Bermuda grass (*Cynodon dactylon*) of this area, the desire being to test the introduced species under competitive conditions to determine its possible value as a pasture grass for the seeped areas near the river levees that are now utilized largely as Bermuda-grass pasture lands. After this grass became well established a very good growth was made during a part of the year and it was apparently able to maintain itself along with the common species, but there was no indication that it was more vigorous or productive. Some seed was produced by this species but not as abundantly as by the local species.

FRUITS.

Orchard fruits grown on the experiment farm made normal development in 1918, although very few changes of importance occurred during the year.

DATES.

In the seedling date orchard, among the 459 palms set out in 1911 there were 147 which produced flowers this season. Of this number only 22 per cent were female trees, contrasted with 78 per cent male trees. This comparison seems to be about the normal relation in earliness of flowering of male trees above female. Twenty-six of these trees matured fruit clusters, including 8 that were of good quality, 11 fair, and 7 poor. The seedling palms of this planting are on poorer soil than other palms and are not much advanced in growth over plantings that were made three years later.

At present 6,670 seedling date palms are growing at this station, of which 1,700 are set in orchard positions, 1,400 along farm roads, and 3,570 are in nurseries ready to be transplanted.

DECIDUOUS-TREE FRUITS.

The investigational work of deciduous-fruit culture at this station has had to do mainly with the testing of many varieties of fruits and nuts, a study of the best methods of pruning and culture, and the selection of other possible varieties from collections of seedlings being grown. Most phases of this work that have thus far given valuable information have been discussed in other annual reports.

TABLE XVII.—*Yields and performance of varieties of deciduous and citrus fruit trees on the Yuma Experiment Farm in 1918.*

Kind and variety.	Age of tree (years).	Tree No.	Flowering date.	Date first ripe.	Date last ripe.	Yield per tree.[1]	
						1918	1917
Apricot:							
Tilton	4	B-2	Mar. 20	June 11	June 17	34	.....
Do	4	B-3	...do	...do	...do	20	11.5
Moorpark	4	B-5	...do	...do	...do	73	16
Blenheim	4	B-6	...do	...do	...do	47	21
Do	4	B-7	...do	...do	...do	67	.....
Royal	4	N-1	Feb. 25	...do	...do	11	.....
Hemskirke	5	N-2	...do	June 17	.....	6	9
Royal	4	N-3	Mar. 23	June 11	.....	13.5	10
Do	5	N-4	Mar. 20	June 1	June 17	83	77
Blenheim	5	N-5	...do	...do	June 11	60	116.5
Tilton	5	N-8	Mar. 25	June 7	.....	8	76
Early Golden	2	X-9	Mar. 18	June 11	.....	1	.....
Cluster	2	X-11	Mar. 24	...do	.....	5	.....
Peach:							
Bell October	4	E-1	Mar. 7	Sept. 2	Sept. 9	31	28.5
Do	4	E-2	...do	...do	.....	12	30
Japan Dwarf	4	F-8	Mar. 25	June 24	.....	2.5	12
Ceylon	5	G-2	Feb. 8	July 19	July 31	81	59.5
Climax	5	G-19	Mar. 14	Aug. 5	.....	12	21.5
S. P. I. No. 32375	4	I-12	.....	Aug. 14	.....	20	74
Imperial	2	L-11	Mar. 12	Sept. 2	.....	2.5	.....
Plum:							
Wickson	4	D-19	Mar. 20	June 24	.....	1	.....
Do	4	D-20	Mar. 25	...do	.....	1	.....
Shiro	5	K-5	Apr. 1	June 19	.....	16	36
Red June	5	K-8	Mar. 30	June 20	June 24	6	.....
Gonzales	4	L-18	...do	June 17	June 20	9	3
Pear:							
P. Barry	5	Q-4	Apr. 12	Dec. 5	.....	4.5	.....
Easter Beurre	4	Q-5	Apr. 15	...do	.....	13	.....
Do	4	Q-6	...do	...do	.....	7.5	.....
Winter Bartlett	5	Q-10	Apr. 19	...do	.....	20	.....
Winter Nelis	5	Q-12	Apr. 18	...do	.....	6	.....
Winter Bartlett	4	V-9	Apr. 19	...do	.....	3.5	.....
Do	4	V-10	May 7	...do	.....	5.5	.....
Do	4	V-11	Apr. 19	...do	.....	6.7	.....
Crocker	4	V-13	Apr. 15	...do	.....	4.2	.....
Do	4	V-14	...do	...do	.....	1.8	.....
Quince:							
Smyrna	4	M-18	Mar. 20	Nov. 7	.....	8	7
Do	4	M-19	...do	...do	.....	17	9
Rea	4	M-22	Mar. 25	...do	.....	6	3
Do	4	M-23	Mar. 20	...do	.....	10	6
Orange	4	W-22	Apr. 1	...do	.....	1	3
Lemon:[2]							
Lisbon	4	C-5	.....	Dec. 5	.....	3	.....
Do	4	C-6	.....	...do	.....	4	.....
Villafranca	4	C-7	.....	...do	.....	1.5	.....
Do	4	C-8	.....	...do	.....	9	.....
Orange:[2]							
Ruby	4	C-19	Apr. 12	...do	.....	1	.....
Do	4	C-20	...do	...do	.....	11	.....
Almond:							
Nonpareil	5	J-1	Mar. 12	Aug. 5	Aug. 12	5.4	.....
Do	5	J-2	Mar. 8	Aug. 12	.....	3.9	.....
I. X. L	5	J-6	...do	July 30	.....	1.1	.....
Ne Plus Ultra	4	J-9	Feb. 23	...do	.....	.1	.....
Do	4	J-10	...do	...do	.....	.1	.....
Pecan:							
Stuart	5	T-12	Apr. 27	Dec. 3	.....	Few.	.....

[1] Except as noted the yields are stated in pounds.
[2] The statement of yields of oranges and lemons is by number of fruits, in dozens.

The dying among these fruit trees which was mentioned in the report of 1917 has continued during this year to a discouraging extent among the four and five year old trees. No pathological disorder has as yet been identified with this loss, but it seems that the ailment is probably a combination of the tree roots reaching the

ground water plane and a distressing amount of alkali in the soil. In addition to the varieties listed in the last report, among which this dying occurred, there were 25 more in 1918. The nature of the gradual dying of a few trees at a time is shown in figure 15.

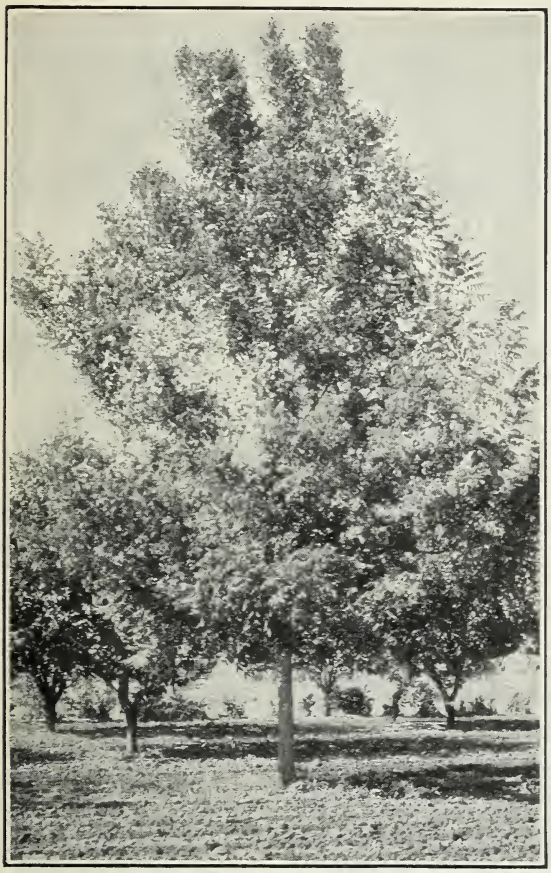
In the seedling hybrid Smyrna-Adriatic fig orchard of 1,615 trees, 384 matured fruit this season, of which 62 were of qualities rated from fair to good. Another attempt was made to establish a colony of the fig insect (*Blastophaga psenes* L.) in this orchard in April, but apparently without success, as there was no wintering-over crop of figs on the trees in early winter.

P6780W1

FIG. 15.—Peerless peach trees, one dead and one healthy, in the variety orchard of the Yuma Experiment Farm in 1918.

Both the named varieties and seedling pomegranates under test produced large crops of fruit this season. Fruit on about 40 per cent of these plants was more or less infected with the recognized, but unidentified, fruit injury of the pomegranate which occurs commonly in the Southwest. From an original total of 327 seedling plants all but 177 have been discarded as not being worthy of further propagation. Some of those remaining have not yet fruited, but about 5 per cent of the original collection have produced fruit of good quality.

Several varieties of deciduous fruits and nuts came into bearing this season. Among these were five varieties of pears, three varieties of almonds, and one pecan. Some of these produced only a few fruits while others bore a fair crop for young trees. In figure 16 is shown a 5-year-old Stuart pecan tree growing in an orchard in the lower Yuma Valley.



P6963W1

FIG. 16.—Stuart pecan tree, 5 years old, growing on the Yuma Reclamation Project in 1918.

In Table XVII are recorded the yields from those trees producing fruit in 1918 as compared with the yields of 1917. The 1918 yields of two lemon varieties and one orange variety growing on the experiment farm are also included. A bearing 4-year-old tree of the Satsuma Blood orange is shown in figure 17. This variety has proved to be particularly hardy and has survived all winter temperatures at the experiment farm since 1914.

GRAPES.

A further report of the performance of grape varieties under test in the variety vineyard at this station is given in Table XVIII. The yields from these vines and the ripening dates during 1918 are compared with similar data of the two previous years. This vineyard is planted at the rate of 435 vines per acre, and these yields are calculated on that basis.

TABLE XVIII.—*Yields of varieties of grapes grown on the Yuma Experiment Farm from 1916 to 1918, inclusive.*

Variety.	Year planted.	Dates of ripening.			Average yield (pounds).			
					Per vine.			Per acre.
		1916	1917	1918	1916	1917	1918	1916 to 1918
Sultanina (*Thompson Seedless*)	1913	June 18	July 10	June 24	9.1	3.62	8.6	3,091
Sultanina rosea	1914	...do			.83			361
Sultana	1913	July 3	July 10	June 24	17	8.50	8.1	4,872
Malvoisie (*Black Malvoisie*)	1914	do	Aug. 2	July 18	1.5	3.87	7.7	1,895
Peru (*Rose of Peru*)	1913	July 28		July 25	7		8.6	3,393
Do	1914	July 7	Aug. 2	...do	1.5	.50	4.5	942
Malaga	1914	...do	...do	July 31	4.7	3	12	2,856
Muscatel Fino	1913	July 8	...do	July 23	4.75	4	4.6	1,934
Mission	1914	July 7	July 21	...do	3.37	.50	3.7	1,096
Dattier (*Dattier de Beyrouth*)	1914	July 11			2			870
Damascus (*Purple Damascus*)	1914	...do		July 23	.5		1	326
Morocco (*Black Morocco*)	1913	...do	Aug. 2	Aug. 14	5.75	1	1	1,224
Alexandria (*Muscat of Alexandria*)	1914	...do	...do	July 29	1.5	3.5	6.2	1,624
Muscat	1914	...do	...do		.66	2.66		722
Almeria	1914	Aug. 16		Sept. 28	.33		5.5	1,268
Albardiens (*Muscat Albardiens*)	1916		July 10	July 23	.33		.5	180
Black Hamburg	1913		Aug. 2	Sept. 6	1		4.5	1,196
Black Prince	1913		...do	...do	1.75		4	1,250
Valdepenas	1916			July 18			.8	348
Listan (erroneously *Golden Chasselas*)	1916			July 23			1.3	565
Cipro Nero	1916			July 25			.5	217
Cornichon (*Black Cornichon*)	1913	July 26		Sept. 6			1.5	652

VEGETABLES.[1]

In each of the annual reports of the work of this station since 1913 some phases of the truck-crop work in progress have been discussed. It is here purposed to give a summary of these several seasons' results with vegetables that may be grown in this climate, along with the results from experiments conducted in 1918. Also, some short discussions are included regarding the cultural methods which have been found to be most successful for particular truck crops under local conditions.

P6957W1

FIG. 17.—A 4-year-old Satsuma Blood orange tree, with crop of 11 dozen fruits, on the Yuma Experiment Farm in 1918.

While garden crops can be grown to some extent throughout the

[1] The writer wishes to acknowledge the valuable services of Mr. C. E. Peterson, assistant, who has conducted most of the tests with truck crops at this station.

year, the most satisfactory practice is to produce a winter and a spring garden. Vegetables that can be grown in the winter garden should be planted during September or early in October. Most of those to be grown in a spring garden should be planted as soon as the danger of spring frosts is past. There is normally a period in the summer from the middle of July until late in September when most truck crops make very poor growth or none at all. Two methods of culture are practiced: (1) Planting on beds and irrigating by means of the furrows between the beds and (2) planting on the flat and then irrigating by flooding or through small furrows made by a cultivator shovel.

Most of the varieties of vegetables recommended by reliable seed houses for this area have been tested in the experiment farm gardens along with other new introductions. It is from the results of these tests that the information regarding varieties which is embodied in the following report has been accumulated.

ASPARAGUS.

Asparagus is successfully grown in this region and has been profitably produced in commercial quantities by several gardeners on the Yuma project. It may be grown on a variety of soils, although the most desirable type is a mellow, rich, sandy loam, which can be readily cultivated. Unlike most garden crops, asparagus thrives on soils which carry a small amount of white alkali, but should not be expected to endure any large amounts of alkaline salts. This plant is a very heavy feeder, and responds to a lavish supply of fertilizers. Regular applications of barnyard manure applied between the rows each winter and worked into the soil with a one-horse plow or a disk cultivator before spring growth begins is very desirable. This keeps the soil open and friable. When more concentrated fertilizers are applied, mixtures which are rich in nitrogen and potash should be used. The extensive root system of the asparagus plant is shown in figure 18, which is a view of an old asparagus field recently plowed with a breaking plow.

This plant propagates readily from seed, and well-grown seedlings are in the best condition to transplant when one year old. The seed bed should be started in February or March. It is sometimes found to be advantageous to soak the seed before planting in order to induce a more rapid germination. The seedlings should be thinned to a space from 3 to 4 inches apart and kept free from weeds. In preparing the field for transplanting, furrows should be laid off 5 feet apart and the plants set 2 feet apart in the furrows. The plants, or roots, should be planted about 6 inches deep, but only lightly covered until stem growth begins. The furrows should then be gradually

filled by cultivations. New plantings should be watered frequently until the plants become well rooted. Very few shoots should be cut until the plants have become well established, which generally requires two to three years. In this climate, if asparagus is not cut too heavily in the spring and is allowed to stand without much water in late summer, it may then be topped and watered and a small crop cut in the autumn without apparent injury to the plants. Spring cutting can generally be begun by February 15. The Giant Argenteuil variety is the best that is known for this region.

BEANS (GREEN).

Most varieties of beans grown for green-vegetable use seem to be too sensitive to the extreme climatic conditions in this region to produce valuable crops. The selection of a variety to be planted is, therefore,

P6860W1

FIG. 18.—An asparagus field on the Yuma Reclamation Project, plowed out with a breaking plow, showing the extensive root development of the crop.

very important. The Stringless Green Pod variety is the only one of the many tested that produces green beans of the best quality. It is a prolific bearer, the pods being tender, not stringy, and of excellent flavor.

BEANS (DRY).

The only kinds of commercial dry beans that have been found to be reliable for field plantings in this climate are tepary, Blackeye, and pink. Pink beans are not always dependable, but during some seasons produce profitable crops. The white tepary and Blackeye are well adapted to local culture and produce good yields. If beans are planted in early spring a crop is often produced before being damaged by the intense summer heat. A second crop, or late summer crop, may be planted about August 1, which may yield well before early frosts occur. However, the summer crop is frequently

badly damaged by the red spider. The tepary bean may be planted almost any time from April to August. About 100 days are required to mature a crop. The late crops ordinarily produce the heaviest yields. Overirrigation should be guarded against, and a thorough cultivation should follow each irrigation until the vines cover the ground. In 1917, a space-between-row test was conducted with this variety. Seeding was made on July 19 in rows 22, 30, and 36 inches apart. All were mature and harvested on November 15, producing yields per acre as follows: 22-inch rows, 1,065 pounds; 30-inch rows, 900 pounds; 36-inch rows, 975 pounds. Rows less than 22 inches apart can not easily be cultivated with horse cultivators. A variety test of dry beans was made at this station in 1918, but with unsatisfactory results, as none of the beans set a usual crop of seed. The climatic conditions during the period of flowering were such as to cause nearly a complete shedding of blossoms. The results of this test are shown in Table XIX.

TABLE XIX.—*Yields of dry beans produced in a variety test on the Yuma Experiment Farm in 1918.*

Variety.	Date planted.	Date harvested.	Number of days to mature.	Yield per acre.	
				Pounds.	Bushels.
White tepary	Mar. 7	June 14	99	148.3	2.48
Pink	...do	...do	99	284.4	4.14
Mexican Red	...do	...do	99	163.4	2.72
Red Kidney	...do	...do	99	145.2	2.42
Blackeye	...do	July 6	121	140.6	2.34
Lady Washington	...do	...do	121	51.3	.85
Lewis Lima	...do	...do	121	39.2	.65
Pinto	...do	June 14	99	56.0	.93
Navy	...do			(1)	(1)
Blue Navy	...do			(1)	(1)

[1] No yield.

BEETS.

Many varieties of table beets do well, but perhaps the most valuable varieties are Early Model and Blood Turnip. Beets are easily grown in the winter garden and make the best development when planted on beds.

CABBAGE.

Cabbage thrives well as a winter vegetable in this climate but does not endure the heat of summer. The seedling plants may be successfully grown in the open garden, but it is generally more desirable to grow the plants in beds and later transplant them to the garden. Such a seed bed may be prepared by mixing well-rotted manure with any good garden soil. The seed should be sown broadcast or in drills and covered one-quarter of an inch deep beneath a very light coating of fine decayed manure. The soil must be kept

moist until the plants are all up, and they should be under a partial shade. The plants should be thinned while small, for crowding will prevent the rugged stocky development that is desired. Seed planted in August or early September should give plants that are ready to transplant to the field by October or early November, which planting time is most desirable.

The most suitable type of soil for cabbage production is a well-fertilized loam. Sandy soil does not develop good heads. Either flat or bed culture for cabbage is satisfactory, but the bed method is generally preferable. When plantings are made on beds the land should be laid off by plowing broad furrows 3½ feet apart and an irrigation applied through these furrows. The plants should then be set at the water line on each side of the furrow from 18 to 24 inches apart. If flat culture is practiced, it is advisible to set the plants from 15 to 20 inches apart in rows 2½ to 3 feet apart. Frequent irrigations are necessary, and a cultivation should follow each irrigation to keep the soil in good tilth and prevent weed growth.

Early-maturing varieties have proved best adapted here. A comparison of the behavior of three of the best varieties for this region which were grown in 1918 is shown in Table XX.

TABLE XX.—*Yields of cabbage varieties grown on the Yuma Experiment Farm in 1916 and 1918.*

Variety.	Date set out.	Dates harvested.		Yield per acre (tons).
		First.	Last.	
Season of 1918:	1917.	1918.	1918.	
Early Winningstadt	Nov. 5	Mar. 19	May 26	16.74
All Season	...do....	Mar. 26	Apr. 26	16.34
Early Drumhead	...do....	Mar. 28	May 26	12.98
Season of 1916:	1916.	1916.	1916.	
All Season	Jan. 14	Apr. 20	June 3	20.91
Early Drumhead	...do....	...do....	...do....	20.37

CARROT.

Carrots should be planted in early September either on beds or on the flat system. They require about the same cultural treatment as beets. The Oxheart variety is the best tested.

CASABA MELON.

The casaba melon has gained popularity rapidly during the past six years. It can be grown in this climate, but not with the same success with which watermelons and cantaloupes are grown. The cultural methods followed are practically the same as for cantaloupes, but the growing period required for maturing the casaba melon is much longer. This carries the ripening season well into the hottest weather of the summer, and much trouble is often encountered from sun-

burning. Also, during late summer, all melon vines are frequently severely attacked by aphids. It has been found to be a very desirable practice to pick casaba melons that are nearly mature and store them in the shade to ripen, preferably in a cellar. The Bidwell variety is the best grown. The Honey Dew is another melon of this same class that has become well known during the last two years.

CAULIFLOWER.

Only the early-maturing varieties of cauliflower should be planted here. Burpee's Early Best and the Dry Weather varieties are both suitable. Cauliflower can only be grown successfully in the winter garden. It requires very rich soil and frequent irrigations. The seed may be started in seed beds in September, much the same as cabbage, and transplanted to the garden in late October.

CHICK-PEA.

Chick-peas, or Mexican garbanzos, are occasionally grown in small areas in some Mexican gardens of this section. Several varieties have been grown at the experiment farm, planted both in the spring and in the autumn. The autumn planting date seems best, although only small yields have been produced from any plantings. When seeded in the spring, this bean develops in a very short season, requiring only about 40 days.

CORN (POP).

Several varieties of pop corn have been tested, but none have yet been found which gave satisfactory yields.

CORN (SWEET).

Most well-known varieties of sweet corn have proved so uniformly unsuccessful in this climate that field-corn varieties of the Mexican June type have been generally grown for green corn. However, the introduction of Papago sweet corn has met the need of a variety that will mature during the high temperatures of this region. It may be planted from February to September, the spring plantings producing roasting ears in about 115 days and the summer plantings in 70 days.

CUCUMBER.

Cucumbers require a rich, medium-heavy loam soil fairly retentive of moisture but with good drainage. The cultural methods that have been successfully followed are about the same as for watermelon production. Ridges prepared for planting should be about 5 feet broad and the hills should be about 3 feet apart on each side of the ridge. Frequent irrigations are necessary. In a variety test made at this station during 1917 and 1918, the yields were secured which are

shown in Table XXI. The varieties White Spine and Long Green are considered especially valuable, the former for pickle making and the latter for salad use.

TABLE XXI.—*Yields of varieties of cucumbers grown on the Yuma Experiment Farm in 1917 and 1918.*

Variety.	Date planted.	Dates harvested.			Yield per acre, (tons).		
		First picked.	Main crop.	Last picked.	Large size.	Medium size.	Total crop.
Season of 1918:							
White Spine	Jan. 30	May 20	July 12.	July 16	11.11	6.64	17.75
Long Green	...do.....	...do.....	July 16	...do.....	10.02	6.35	16.37
Season of 1917:							
Fordhook Famous	Jan. 23	May 31	July 3	Aug. 6	4.82	2.71	7.53
White Spine	...do.....	...do.....	....do....	...do.....	4.57	2.47	7.04
Long Green	Jan. 27	June 8	July 12	...do.....	4.79	2.47	7.26
White Spine	Feb. 14	June 11	July 26	Aug. 14	4.05	2.44	6.49
Long Green	...do.....	...do.....	July 12	...do.....	3.36	2.07	5.43

EGGPLANT.

The eggplant is very easily grown as a spring and summer garden plant. The seedling plants may be started in a hotbed and transplanted to the field much the same as tomato plants, or the seed may be planted directly in the garden. Black Beauty has been found to be a very reliable variety.

FENUGREEK.

One variety of the beanlike legume fenugreek has been tested here. Planted on November 9, the seed was mature on June 12 and yielded at the rate of 6.81 bushels per acre.

GARLIC.

Garlic can be grown in the garden by about the same methods that are required for the production of onions by sets. It is a plant that endures winter frosts in this climate without injury and should be planted during late September or early October. Either the entire bulb is planted or the bulb is divided into the bulblets, or cloves, of which it is composed and these cloves planted in rows. A comparison of these two methods of propagation covering two seasons has been conducted, with the results shown in Table XXII. Plantings were made in beds from 3 to 3½ feet across, with a row on each side of the bed. Irrigations were applied through the furrows between the beds.

It will be observed that while the largest yield came from the whole-bulb planting in 1917, this relation was reversed in 1918. In each test the bulbs produced were larger and more uniform from the cloves than from the whole bulbs. It also requires much less seed to plant the cloves, and considered as a whole this seems to be the most profitable practice.

TABLE XXII.—*Yields of garlic grown on the Yuma Experiment Farm in 1917 and 1918.*

Kind of seed tubers.	Dates.		Distance apart (inches).		Yield per acre (pounds).
	Planted.	Harvested.	Rows.	Plants.	
Season of 1918:					
Whole bulbs	Oct. 5	June 8	18	6	8,356
Cloves	do	do	18	6	9,669
Season of 1917:					
Whole bulbs	Sept. 28	June 29	21	12	6,846
Cloves	do	June 9	21	4	4,929

KOHL-RABI.

This crop belongs to the same class of vegetables as cabbage, kale, and cauliflower and may be grown in the same manner as cabbage. White Vienna is the best variety tested.

LENTILS.

Lentils planted on light soil on November 9 developed 2.6 bushels of seed per acre, which was harvested on June 12. So far as known, there have been no extensive tests of this bean on the project or any profitable yields obtained.

LETTUCE.

The winter head-lettuce industry has never been developed extensively on the Yuma project, but in both the Imperial Valley and the Salt River Valley large commercial quantities of head lettuce have been produced for several seasons. Lettuce of equal quality may be produced here if careful attention is given this crop. Lettuce requires a rich, loose soil and frequent irrigations. All varieties grow well but the head-lettuce varieties are exceedingly good. Among the best of these are the Wonderful and Prize Head.

MUSKMELON.

The muskmelon crop develops very well under local conditions, and about the same cultural methods should be followed as are described for watermelon production in a following paragraph. The Rocky Ford and Emerald Gem varieties are both well adapted. The former is well known and produces the larger yield, while the latter ripens a little earlier and is excellent for home use. An average yield of 150 crates per acre may be expected, while yields of 250 crates per acre are not uncommon.

OKRA,[1] OR GUMBO.

During the past year, a preliminary test was conducted with okra to ascertain what might be done in this climate toward the production

[1] This test was conducted in cooperation with the Office of Cotton-Breeding Investigations.

of okra seed for oil. A tenth-acre plat was planted on June 13 in rows 36 inches apart and was cultivated much the same as cotton. From this planting mature seed was harvested in early December at the rate of 584 pounds per acre. It is recognized that this crop should be planted much earlier to secure maximum production, and with this view the test will be conducted during next season. This crop grows with much vigor under these conditions, as is shown in figure 19. The green pods produced were of excellent quality for table use, and it seems that the plant will continue to set pods until frost whether or not the mature pods are harvested when ripe.

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FIG. 19.—Plat of okra growing on the Yuma Experiment Farm in 1918.

ONIONS (DRY).

It has been demonstrated that onions in this climate will produce excellent yields and can be matured in time for an early market. However, the industry has not been developed commercially as yet. A light well-fertilized sandy loam will be found most desirable for this crop. Even slightly alkaline soils should be avoided, especially where onions are to be grown by the bed method. The White Bermuda and Crystal Wax varieties succeed very well. The Australian Brown variety is also well adapted to local conditions and of all varieties tested will keep best in storage. Its season, however, is later than the Bermuda types of onions. Onions may be seeded either in beds, to be later transplanted, or be planted in the field rows. If transplanted, an opportunity is afforded to select the seedlings to be retained and to discard the less vigorous plants. How-

ever, the tests conducted at this station have failed to show any advantage gained in yields by transplanting onions. A test of this sort made in 1915 has been heretofore reported.[1]

If onions are planted on the flat, the rows should be 12 to 15 inches apart to be cultivated with hand tools or not less than 24 inches apart if a horse cultivator is used. When plantings are made on beds, a desirable arrangement is to lay off beds with furrows every 3 feet, planting two or three rows of onions on each bed.

ONIONS (SEED).

Onion-seed production likewise shows possibilities of being made a very profitable enterprise in this locality. Various tests conducted have demonstrated the reliability of such production if carefully handled, and a few gardeners have already produced good crops of onion seed.

In September, 1915, bulbs of White Bermuda and Crystal Wax onions specially selected for seed production were planted on beds by the same method as for market onion production. Bulbs ranging in size from 1½ to 4 inches in diameter were planted 3 inches apart in the row. The quantity of bulbs necessary to plant an acre by this method is about 13,090 pounds, or 238 bushels. The seed was mature and harvested in the following May, the White Bermuda yielding 1,305 pounds per acre and the Crystal Wax 1.351 pounds per acre. At that time these onion bulbs planted were worth about 3½ cents a pound. This would require an outlay of $458 per acre for seed onions, but onion seed if sold at one-half the normal prices would, at this rate, give a handsome net return per acre. The most difficult problem to be met in such an enterprise is probably that of holding over the desirable bulbs from harvest time in May or June until planting time in September, as onions do not keep well during the hot summer.

Another test of onion-seed production was made in 1918, the results of which are recorded in Table XXIII.

TABLE XXIII.—*Seed yields of onion varieties grown on the Yuma Experiment Farm in 1918.*

Variety.	Date planted.	Date harvested.	Method of planting.	Yield per acre (pounds).	
				In 1918.	Comparable in 1916.
White Bermuda	Oct. 5	May 29	Bed	1,393	1,305
Do	Oct. 8	do	Flat	1,754	
Crystal Wax	Oct. 5	do	Bed	1,277	1,351
Do	Oct. 8	do	Flat	1,258	

[1] Blair, R. E. The work of the Yuma Reclamation Project Experiment Farm in 1915. U. S. Dept. Agr., Bur. Plant Indus., West. Irrig. Agr. Cir. 12, p. 20. 1916.

The plats included in Table XXIII that were planted on the flat method were in rows 18 inches apart.

Some skepticism has been expressed by seedsmen regarding the worth of locally produced seed, as compared with imported seed. In order to test such seed thoroughly in comparison with imported seed as sold by reputable seed dealers, plantings were made in 1918 with seed of each sort, including the two varieties White Bermuda and Crystal Wax. The results of this test are given in Table XXIV.

TABLE XXIV.—*Yields of onion varieties grown from locally produced and imported seed on the Yuma Experiment Farm in 1918.*

Variety.	Seed used.	Planting system.	Date.		Yield per acre.	
			Sown, 1917.	Harvested, 1918.	Pounds.	Tons.
White Bermuda	Imported	Bed	Sept. 29	June 4	14,170	7.09
Do	Local	do	do	do	26,467	13.24
Do	Imported	Flat	Oct. 4	do	22,500	11.25
Do	Local	do	do	do	36,875	13.44
Crystal Wax	Imported	Bed	Sept. 29	do	20,962	10.48
Do	Local	do	do	do	19,909	9.95
Do	Imported	Flat	Oct. 4	do	29,062	14.53
Do	Local	do	do	do	31,250	15.63
Average of imported seed						10.84
Average of local seed						13.07
Average of bed method						10.19
Average of flat method						13.71

In every comparison but one, the locally produced seed gave a better yield of onions than the imported seed. The average of all plats shows an increased yield in favor of the locally grown seed of 2.23 tons per acre. The onions in these plats were free from thick-necks or plants with seed stalks. From these data it is apparent that onion seed grown under local conditions is in inherent qualities not only equal but superior to imported seed for onion production in this region.

From Table XXIV it will also be seen that the average of yields from the flat-planted plats is 3.52 tons per acre greater than from the plats planted on beds. However, the individual onions from the bed plantings were larger than those from plantings made on the flat. The largest yields from experiments with onions produced at this farm were obtained in 1917, when bed plantings of the White Bermuda variety yielded 30.65 tons per acre and of Crystal Wax, 30.20 tons per acre.

PARSNIPS.

Parsnips may be grown with a fair degree of success here, but the quality is not equal to those produced in more northern climates. The Guernsey is a good variety. The culture required is similar to that of beets or carrots.

PEAS.

Peas as a winter crop offer a commercial possibility of considerable importance. They may be grown on widely varying soils, although a fertile loam is best. This crop may be planted from September 1 to February 1, but the late plantings will give light yields. Early dwarf varieties planted in September often produce green peas ready to pick during November. If this early crop is caught by autumn frost, another crop develops on the same vines in the spring. The later maturing varieties sown in October will produce a good crop in February. Several of the most promising varieties of peas have been grown in a varietal test during the past three years, the results of which are given in Table XXV. All of the first five varieties listed in this table are of good quality and worthy of recommendation for home gardens.

TABLE XXV.—*Yields of varieties of green peas grown on the Yuma Experiment Farm in 1916, 1917, and 1918.*

Variety.	Date.		Yield per acre (pounds).			3-year average.	
	Average planting.	Main crop picked.	1916	1917	1918	Pounds.	Tons.
Pride of Cahuenga	Oct. 2	May 1	10,123	9,090	[1]6,956	8,723	4.36
Yorkshire Hero	...do.....	Apr. 10	8,887	8,094	[1]6,689	7,890	3.94
Dwarf Telephone	...do.....	...do.....	10,857	5,382	6,562	7,600	3.80
Little Marvel	...do.....	Mar. 20	.....	7,585	9,738	8,661	4.33
Premium Gem	...do.....	Apr. 5	6,282	7,361	8,417	7,353	3.67
American Wonder	...do.....	.....	5,427	.....	.....	5,427	2.71
Nott's Excelsior	...do.....	Apr. 6	3,782	6,922	6,113	5,606	2.80
Stratagem	...do.....	Apr. 4	.....	4,417	7,124	5,770	2.88
Gradus	...do.....	.....	3,609	.....	.....	3,609	1.85
Alaska	...do.....	Mar. 20	.....	2,577	8,291	5,434	2.71

[1] Poor stand.

PEANUTS.

The sandy loam soils on the Yuma project are very suitable for growing peanuts. Seed should be planted in March. The growth and setting of nuts will generally continue until checked by an autumn frost, but not less than 155 days should be allowed to mature a profitable crop. Nearly all varieties do fairly well. The Spanish variety will produce the heaviest yield of nuts, but, being small, must be sold to a factory producing shelled peanuts or peanut butter. The larger varieties, valuable for vending purposes when roasted, which have succeeded well in this region are the Tennessee Red and the Virginia Bunch.

PEPPERS.

Peppers produce good crops in this locality. The propagation and cultivation required are about the same as for tomatoes and eggplants. Varieties of both sweet peppers and hot peppers have been

tested which succeeded well. The varieties of sweet peppers recommended for planting here are the Chinese Giant and the Bell; of hot peppers, Red Cayenne and Red Cluster.

POTATO.

The best potato yields known in this region can not compare favorably with the yields in regions most suitable to potato production, but this crop may be profitably grown if the proper selections of soil and varieties are made. A rather light, rich loam soil with abundant organic matter is desirable. Land that has had an alfalfa sod turned under is generally good, and the addition of barnyard manure is especially advantageous. Heavy soils are improved by the addition of any coarse organic matter which should be applied during the crop of the preceding year.

Early planting is imperative, for the growing season for the potato is short, as it is limited by winter frosts at one extreme and severe summer heat at the other. Only early-maturing varieties are dependable, as the crop must be made before the summer heat begins; otherwise the yields will be greatly reduced. The most desirable planting time is about January 15, or as soon thereafter as weather conditions permit. Previous to planting, the field should be well irrigated and then plowed as soon as it is sufficiently dry. It should then be laid off in rows 3½ feet apart and the seed dropped 12 inches apart in the row, being covered to a depth of about 4 inches. The field should then be thoroughly harrowed until level and in good tilth. As long as the earth remains moist no further irrigation is necessary, but good cultivation should be maintained and weed growth kept down. When irrigation is necessary, it should be applied through furrows between the rows. Frequent irrigations should be avoided, as too much water causes growth of large vines and few potatoes. When the potato tubers are well formed great care should be exercised in irrigating. On most soils a late irrigation is not necessary. One or two irrigations will usually mature a crop.

Varietal tests have been conducted at this station for the past five years with many early varieties. The results of these tests indicate that the most suitable varieties for this region are the following, in the order named: Irish Cobbler, White Rose, Red Triumph, and Early Ohio. The 5-year average production of marketable potatoes for the Irish Cobbler variety is 86.5 bushels per acre. Usually this variety has made greater yields than all others. However, in 1918 the highest yielding variety was the White Rose, with a yield of 168 bushels of marketable potatoes per acre. Both of these varieties produced potatoes of very good quality.

It has always been found difficult to keep potatoes for many weeks in this climate, and as a result no stocks of locally produced seed potatoes are carried over for planting the next year. The early planting date necessary for maximum production sometimes complicates the seed-supply situation, as it is difficult to ship from northern and eastern areas on account of the danger that the potatoes may be frozen in transit. This has led to trials of immature seed, locally grown the previous autumn, in comparison with eastern seed, but the results do not warrant such a practice, as the eastern seed produced the best yields. The Irish Cobbler has been found to be the best summer keeper of all the varieties grown.

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FIG. 20.—A field of stock pumpkins grown on the Yuma Reclamation Project in 1918.

PUMPKIN AND SQUASH.

Pumpkins and squashes may be grown with about the same treatment as watermelons. Two good pumpkin varieties are the Large Cheese and the Cushaw. The former is often grown for stock feed, as is shown in figure 20. Winter squashes do not do well in this climate, as the fruit sunburns badly during the hot summer and the vines are severely attacked by aphids. The summer squash succeeds well, and the Mammoth White Bush Scalloped is the best variety yet tested.

RADISH.

Nearly all radishes succeed very well, but the quickest growing varieties are best. The best of the small red varieties are the Early

Scarlet Turnip and the Scarlet Globe. Long White Spanish and Icicle are excellent long white varieties. Seed should be planted at frequent intervals from autumn to spring, in order to maintain a supply of crisp radishes. Good radishes can not be expected to develop during hot weather.

ROSELLE.

In this climate, having a long frost-free growing season, the roselle plant may be successfully grown. Although of rather recent introduction in this country, in regions where it is known it is highly valued for the edible, fleshy calyxes, which are used in making excellent jellies and jams. The color and flavor of these products are very similar to those made from red currants. The roselle is an annual that is propagated from seed. The seed should be planted in early spring in a protected seed bed and not transplanted to the field until all danger of frost is past. Any rich friable soil is suitable. The rows should be located 6 to 8 feet apart, and plants should be placed about 6 feet apart in the row. The production of roselle flowers does not begin until late in the autumn, no matter when the seedlings are planted. The advantage of early planting is important, however, that a large plant may develop and afford space for a great number of flowers when fruiting time arrives.

SPINACH.

Spinach may be grown readily in the winter garden. It should be given about the same treatment as lettuce and requires frequent irrigations in order to maintain a continuous growth, which is essential to produce tender and crisp leaves. The Savoy is a well-known variety of value.

SWEET POTATO.

Large areas of land on the Yuma project are suitable for sweet-potato production. While this fact is generally realized, no extensive production of this crop has developed, owing to difficulties presented in marketing. A rich sandy soil is the most suitable for sweet-potato culture. Exceedingly deep plowing should not be practiced in preparing ground for sweet potatoes, as a firm subsoil tends to reduce the production of long stringy potatoes, which are undesirable. The ground should be prepared by plowing ridges 3½ feet apart and the plants set in rows on one side of the ridge, spacing them from 12 to 15 inches apart. When the plants are well established and the runners have started, the soil should be worked to the plants on the furrow side of the row by plowing from the side of the adjoining ridge, thus locating the rows in the center of the ridges. The sweet potato is tolerant of drought, but readily responds to ample irrigation. Larger crops are produced and the

potatoes develop nearer the surface of the ground when sufficient water is supplied. Until the furrows are covered with vines the young plants should be irrigated every 7 to 10 days, followed by cultivation. Frequent and light irrigations are more desirable than heavy irrigations at longer intervals.

From early varietal tests conducted at this station it has been found that the White Vineless variety is one of the most dependable. This variety has been grown in cultural tests for some time and from a 4-year average shows a yield at the rate of 9.53 tons per acre. In 1918 a varietal test of six standard varieties gave comparable yields, as shown in Table XXVI.

TABLE XXVI.—*Yields of sweet-potato varieties grown on the Yuma Experiment Farm in 1918.*

Variety.	Date.		Width of ridges.	Space between plants in rows (inches).	Yield of marketable potatoes per acre.		Size.	Quality.
	Planted.	Harvested.			Pounds.	Tons.		
White Vineless	Apr. 8	Dec. 13	3 feet	12 to 14	21,473	10.73	Large	Excellent.
Large White	Apr. 23	do	do	do	14,522	7.26	Medium and irregular.	Poor.
Yellow Nansemond	Apr. 8	do	do	do	9,336	4.66	Medium to small.	Good but fibrous.
Yellow Jersey	Apr. 23	do	do	do	6,950	3.47	Small	Not mature.
Red Jersey	do	do	do	do	4,668	2.33	do	Do.
Porto Rico yam	do	do	do	do	4,149	2.07	Large but irregular.	Fair but fibrous.

The sweet potatoes which are to be bedded for the production of plants for next season's growth should be carefully selected and should be the type of potato that is desired to be produced. A rather common, but undesirable, practice in this region for securing sweet-potato plants or slips for planting is that of pulling plants which usually sprout in the ground where the crop was grown the previous year. Many of these plants come from the fleshy fibrous roots that were left in the soil and did not winterkill and when further propagated do not produce desirable potatoes.

TOMATO.

Although tomatoes are more exacting in their requirements than most vegetables, they can be very successfully grown in this region if given proper care. Few vegetables are more acceptable to most people during the hot season of this climate, and tomatoes should be included in every summer garden. The tomato will thrive on various types of soil, although light silt or sandy loam is preferable. An exceedingly heavy soil induces excessive plant growth and less fruit, while a sandy soil produces small plants and light yields. Applications of barnyard manure plowed under are very profitable, but should be added to the

field at least three months before the tomato plants are set out. About 20 tons per acre is a desirable application. Land should be avoided that has been in tomatoes the previous year if any disease injury has occurred, as many plant diseases live over the winter in the soil. Tomato plants are usually started in hotbeds or covered coldframes, the seed being sown about the first of January. A test of three approved methods of starting tomato plants, including 11 good varieties made in 1917 at this station has been heretofore reported.[1] These methods were three in number, as follows: (1) Seeding and growth until time for transplanting in the hotbed, (2) transplanting to paper pots four weeks after seeding in the hotbed and pots placed in a coldframe until time for transplanting to the field, (3) seeding directly in paper pots placed in a hotbed and plants later thinned to one plant per pot. On April 3 all plants were transplanted to the field. There was little difference in the earliness of maturing of the crops, but there were very important differences in the total yields of the season. Those plants grown in pots in the hotbed produced an average of 40 per cent more tomatoes than those in ordinary beds in the hotbed and 42 per cent more fruit than plants transplanted to pots and placed in the coldframe.

TABLE XXVII.—*Yields of tomato varieties planted on March 25, 1918, on the Yuma Experiment Farm, compared with yields of other years.*

Variety.	Dates of ripening.			Yields per acre (pounds).				Rank of average yields.
	First picked.	Main crop.	Last picked.	1914	1917	1918	3-year average.	
First Early	June 17	July 12	July 27	32,670	15,711	6,380	18,254	1
June Pink	...do.....	...do.....	...do.....	21,030	12,072	6,860	13,321	2
Matchless	June 22	...do.....	July 31	18,100	10,553	4,945	11,199	3
Chalk's Early Jewel	June 17	...do.....	July 22	.....	10,115	9,398	9,757	4
Earliana	...do.....	...do.....	July 31	21,690	3,125	4,170	9,662	5
Quarter Century	...do.....	...do.....	...do.....	8,340	11,664	5,893	8,632	6
Dwarf Stone	...do.....	...do.....	...do.....	.....	10,379	4,433	7,406	7
Dwarf Giant	July 2	...do.....	July 18	10,700	7,722	384	6,269	8
Hummer Globe	June 19	...do.....	July 31	.....	7,582	3,497	5,540	9
Stone	June 27	...do.....	...do.....	.....	4,561	4,785	4,673	10

In preparing the field for planting, ridges 5 feet wide should be plowed up, leaving furrows between. The plants should be placed in rows on one side of each ridge near the water line of the furrow. When well rooted, the earth should be plowed toward the plants, thus filling the furrows, placing the rows in the middle of the beds, and allowing the new intervening furrows to remain open for supplying irrigation water. Frequent light irrigations should follow throughout the season, but heavy irrigations should be avoided, lest large vines and little fruit be produced. Excessive irrigations will frequently cause a shedding of blossoms. Also, flowers opening during

[1] Blair, R. E. The work of the Yuma Reclamation Project Experiment Farm in 1917. U. S. Dept. Agr., Bur. Plant Indus., West. Irrig. Agr. Cir. 25, pp. 42–43. 1918.

very hot weather do not set fruit. Tall-growing varieties should be spaced 4 feet apart in the row, and the more dwarf types should be spaced at 3 feet between plants. Dwarf varieties have generally given the best results, as they produce abundant foliage to protect the fruit from sunburn. Table XXVII presents the comparable performance of several of the best adapted varieties, as grown in the experiment garden at this farm for three years.

TURNIP.

Turnips may be easily grown in the winter on any good garden soil. Seed should be sown thickly in rows about 15 inches apart, either in beds or on the flat. When the plants are well started they should be thinned to about 3 inches apart in the rows. If this thinning is delayed until the leaves are 4 to 5 inches high, the plants taken out may be used for greens. The White Milan and Purple Top Strap Leaf varieties have been found to do well.

WATERMELON.

This region is especially suitable for the production of watermelons. While many varieties do well, there are great differences of quality among the melons produced. The varieties found to produce the best yields and fruit of superior quality are the first four listed in Table XXVIII, giving the results of variety tests conducted at this station in 1914 and 1915.

TABLE XXVIII.—*Yields of varieties of watermelons in a 2-year test on the Yuma Experiment Farm in 1914 and 1915.*

Variety.	Date first ripe.		Yield per acre (tons).			Average weight per melon (pounds).	
	1915	1915	1914	1915	Average.	1914	1915
Black-Seeded Chilean	June 12	June 15	16.16	20.01	18.09	13.9	13.16
White-Seeded Chilean	June 14	June 14	15.36	26.35	20.85	15.2	13.44
Kleckley Sweet	June 12	June 5	9.51	31.68	20.59	12.1	10.10
Klondike	...do....	June 12	17.82	18.21	18.01	13.9	15.90
Brazilian	June 29	.....	2.75	.....	2.75	11.0	.....

The Kleckley Sweet is excellent for earliness and for home consumption, but is too tender to be best for shipping. Both the Black-Seeded and the White-Seeded Chilean watermelons are of excellent quality and are also good shippers. The Klondike is probably the best of these four varieties for shipping, as it is generally somewhat larger than the other varieties and has a very firm rind.

As the profitableness of commercial melon production in this section is largely dependent on reaching an early market, considerable care and extra labor are justified in starting the plants early. In an

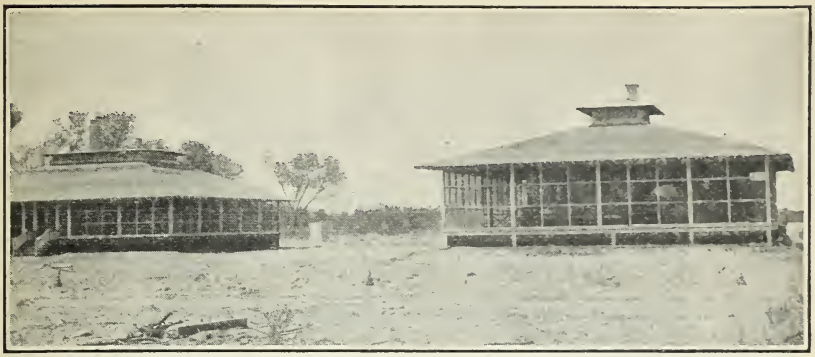
experiment where the plants were started early in paper pots and later transplanted to the field, the yields were not equal to plantings made directly in the field. The most successful practice to increase the earliness has been to plant about January 15 and cover each hill with a small piece of oiled paper to protect the young plants from frost and concentrate the heat from the sun under this paper. The paper is held down by earth piled on each corner. After the plants have come through the ground, this paper cap should be slit to permit accumulated vapor under the paper to escape. Otherwise, the scalding of tender plants may sometimes develop.

The best preparation of ground for planting melons consists of plowing ridges 8 feet wide, leaving a well-formed furrow between the ridges for applying water and affording dry soil on the ridge for the support of the vines and melons later in the season. If the ridges are laid off in an east-to-west direction, the hills can be planted on the south side of the ridge, which affords a warm exposure and promotes an early germination of the seed. The plants should be thinned to one in a hill as soon as the second leaf is well formed. The ground should be kept well cultivated and free from weeds until the vines cover the ground. Frequent irrigations are essential, although a large quantity of water is not desirable at any application.

ORNAMENTAL TREES AND SHRUBS.

As the greater part of the early development work of the Yuma project has been accomplished, many residents of both towns and country are devoting more attention than during former years to establishing permanent plantings of ornamental trees and plants that may add comfort and beauty to the homes. Fertile soil, abundant water, long growing seasons, and mild winter temperatures afford great possibilities for the growth of many types of ornamental plants. However, there are important limiting factors that should be recognized in selecting varieties for such plantings. The most restrictive of these conditions is the period of high temperatures which prevails during the summer months.

Many of the ornamental plantings on the grounds and in the nurseries of the Yuma Experiment Farm have been established for five or six years and now afford some information as to desirable varieties that may be planted. Figure 21 shows a view of the buildings and grounds of this farm in 1911 before ornamental plantings were made. This figure should be compared with figures 25 to 32, inclusive, which show sections of the same grounds six years later. Emphasis should be directed to the desirability of planting many evergreens in this climate, as the mild temperatures permit many plants of this type to succeed remarkably well.



P6856W I

FIG. 21.—View of the buildings on the grounds of the Yuma Experiment Farm in 1911, before ornamental plantings were made.

PALMS.

The group of ornamental palms embraces several species that develop rapidly under local conditions. The well-known California Fan palm thrives well and makes rapid growth during the hot summers. Two species in this group seem equally well adapted, *Washingtonia filifera* and *Washingtonia robusta*. A typical plant of the former species, bearing a crop of mature seed, is shown in figure 22.

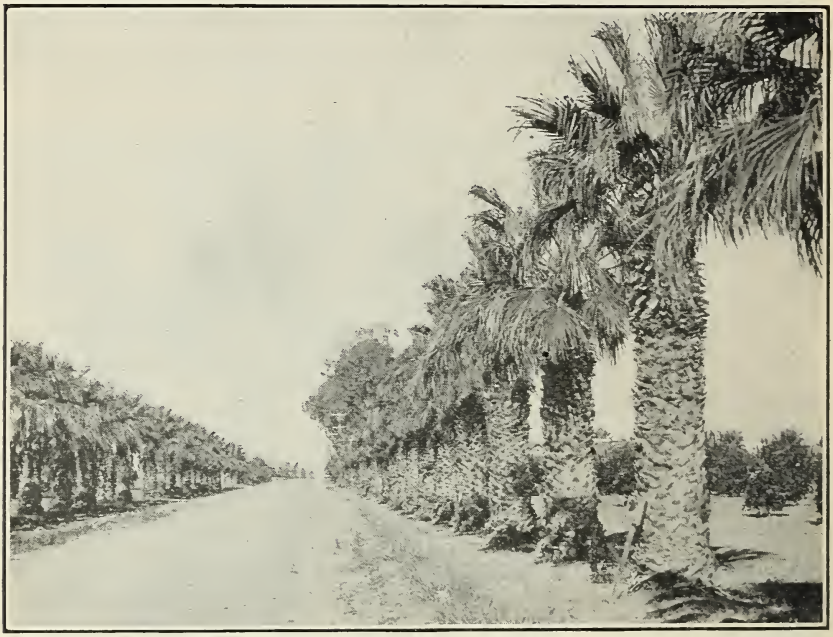
Either of these species is suitable for avenue planting. Figure 23 shows an avenue on the Yuma project planted to *Washingtonia filifera*.

The next most vigorous palm which is known to do well in

P6985W I

FIG. 22.—A palm tree (*Washingtonia filifera*) bearing fruit, growing on the Yuma Reclamation Project in 1918.

this locality is *Phoenix canariensis*, or the ornamental date palm. The true date (*Phoenix dactylifera*) is sometimes planted as an ornamental, but the tree is not nearly so handsome as the ornamental species. *Erythea armata*, commonly called the blue palm, is of rather slow growth, but a variety distinctly worthy of being planted. This palm has large deeply cut fan leaves of a bluish gray color, which is much more distinct on rather mature palms than on the foliage of young plants. Two other species of this genus are making very good growth in this climate as young palms, namely, *Erythea edulis* and *Erythea brandegeei*.



P6984W1

FIG. 23.—An avenue planting of palm trees (*Washingtonia filifera*) on the Yuma Reclamation Project in 1918.

EVERGREEN TREES.

Among the evergreen trees that may be grown successfully in this region, probably none are as important as the various Eucalyptus species which will succeed here. These trees are not only desirable as rapid-growing ornamentals but may be utilized in windbreak plantings, while the wood is valuable for both posts and fuel. The best known well-adapted species are the desert gum (*Eucalyptus rudis*) and the red gum (*Eucalyptus rostrata*). Two other species, *Eucalyptus tereticornis* and *Eucalyptus robusta*, have made very satisfactory growth and seem to withstand both summer heat and winter temperatures as low as 17° F. Although difficulty is often experienced in growing small Eucalyptus plants through periods of heavy

winter frosts, not much injury is encountered after the trees are at least 2 years old. Eucalyptus trees are propagated from seed and should be transplanted from the seed bed to pots and from the pots to their permanent locations while still small. It is very difficult to transplant larger Eucalyptus trees without a high percentage of loss. A view of *Eucalyptus rostrata* trees growing as a windbreak on the Yuma project is shown in figure 24.

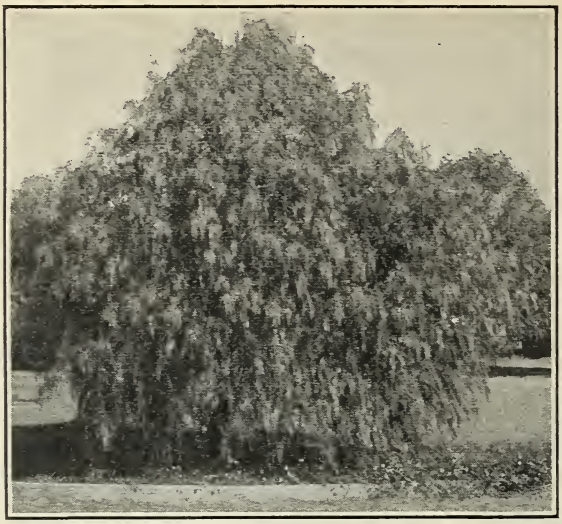
Other evergreen trees that may be planted here are the beefwood or she oak (*Casuarina stricta*); *Tamarix articulata;* pepper (*Schinus*

P6983W1

FIG. 24.—*Eucalyptus rostrata* growing as an orchard windbreak on the Yuma Reclamation Project in 1918.

molle), and the Arizona cypress (*Cupressus arizonica*), Monterey cypress (*Cupressus macrocarpa*), and Italian cypress (*Cupressus sempervirens*). Pepper trees and Arizona cypress trees, as grown on the experiment farm grounds, are shown in figures 25 and 26, respectively.

The Casuarina is a genus of jointed-twig leafless trees which have a distinctly peculiar effect in the landscape. This tree can be propagated easily and grows as rapidly as the Eucalyptus. *Tamarix articulata* makes an extremely rapid growth, will tolerate high summer temperatures, and may be grown in soils that are slightly alkaline.



P6796W I

FIG. 25.—A 5-year-old pepper tree growing on the grounds of the Yuma Experiment Farm.

This is one of the most rapid and largest growing forms of this genus. It was introduced into the Southwest for trial by Mr. John J. Thornber, botanist, of the University of Arizona.

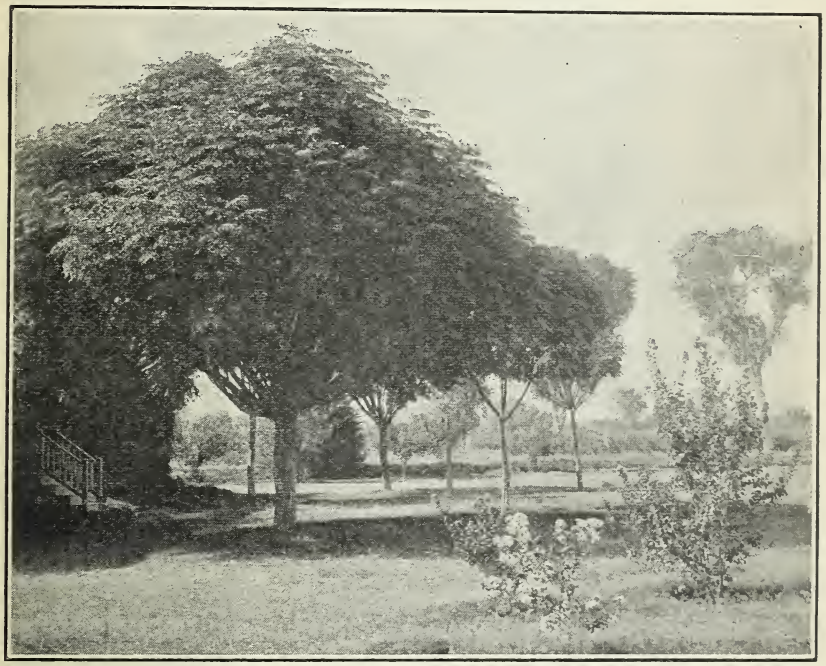
Both the Arizona and the Monterey cypresses make a fairly rapid growth and form trees of stately proportions. The Arizona variety is of a bluish gray color, which is maintained the year around, while the Monterey is of a rich deep-green color. The Italian cypress is a tall, tapering tree of the formal type.

P6797W I

FIG. 26.—Arizona cypress trees with pampas grass and *Eucalptus rudis* in the background, on the grounds of the Yuma Experiment Farm in 1918.

DECIDUOUS TREES.

Four species of deciduous trees that are indigenous in this area can often be used on the farmstead to good advantage. These trees are the native willow (*Salix nigra vallicola*) cottonwood (*Populus macdougalli*) mesquite (*Prosopis juliflora velutina*) and palo verde (*Parkinsonia torreyana*). The willow and cottonwood may be readily transplanted as trees 1 or 2 years old. The mesquite may be transplanted successfully when very small, but the palo verde had best be propagated from seed and always transplanted with the roots balled. Willow, cottonwood, and mesquite should be pruned back



P6843W1

FIG. 27.—Umbrella trees, with crape myrtle in the foreground, on the grounds of the Yuma Experiment Farm in 1918.

thoroughly and moved while dormant. The native Mexican ironwood tree (*Olneya tesota*) may be utilized in some instances as an ornamental, but it has been found to be exceedingly difficult to transplant successfully and should, therefore, be started from seed in pots. The growth of this tree is very slow.

Other well-known deciduous trees that are valuable for shade and rapid growth are the following: Umbrella (*Melia azedarach*), Carolina poplar (*Populus deltoides carolinensis*), weeping willow (*Salix babylonica*), and the mulberries (*Morus alba* and *M. rubra*). A pleasing effect of the umbrella tree used in group planting for backdoor shade is shown in figure 27. Among the recent introductions

tested, the Chinese elm (*Ulmus pumila*), has proved to be a very desirable shade tree for the Southwest. In this section the tree grows rapidly and should be given an important place among plantings, as it is the only elm known to develop normally in this region of high summer temperatures and dry atmospheres. A 5-year-old tree of this species growing on the experiment farm grounds is pictured in figure 28.

Other deciduous trees of ornamental value that are well adapted to this climate and soil, but of slower growth, are the Arizona ash (*Fraxinus velutina*) and the Jerusalem thorn or horse bean (*Parkinsonia aculeata*). The Parkinsonia is valued for its feathery drooping branches and small, but abundant, yellow flowers, which are persistent for a long period in the spring. A view of a 4-year-old Parkinsonia tree on the Yuma Experiment Farm is shown in figure 29.

P6791W1

FIG. 28.—A 5-year-old Chinese elm tree, with chrysanthemums at its base, on the grounds of the Yuma Experiment Farm in 1918.

EVERGREEN SHRUBS.

The flowering evergreen shrubs generally add more permanent beauty to lawn or park plantings than others that may be used. Those that have proved their worth in this region are *Escallonia alba*, oleander (*Nerium lauriforme*), and everblooming bush roses. The white-flowering species of Escallonia has succeeded well here, while the red-flowering form has not been grown successfully. Both the white and pink oleanders blossom profusely and are very vigorous in growth. Among the evergreen shrubs of less conspicuous flowers that are suitable for planting are the Carolina cherry laurel (*Prunus*

caroliniana), loquat (*Eriobotrya japonica*), and several species of arbor vitæ. There are at least four species of arbor vitæ that do well, namely, Chinese (*Thuya orientalis*), Chinese Golden (*T. orientalis aurea*), Giant (*T. plicta*), and Japanese (*T. orientalis filiformis stricta*). Thuya is a genus of hardy coniferous evergreen plants that are known to be adapted to cooler climates, but these species are likewise proving suitable for ornamental plantings in warm valleys of the Southwest.

P6514W1

FIG. 29.—A 4-year-old Parkinsonia tree on the Yuma Experiment Farm in 1918.

BUSH ROSES.

The group of highly ornamental flowering roses is exceedingly valuable in this region. Many varieties grow and flower luxuriantly if planted in a good soil and given ordinarily good care. While the bush rose is not entirely evergreen in this region, it may be considered as nearly so. Roses succeed best in a deep, rich, loam soil which is well drained but supplied with frequent irrigations. In places where the soil is shallow, it is necessary to remove the natural soil and replace it with a loam soil well enriched with decayed stable manure. Some varieties may be propagated by cuttings, although it is generally profitable to secure rooted plants from a reliable rose nursery. Those varieties should be grown which produce flowers during nearly all months of the year. The groups of teas, hybrid teas, and some hybrid perpetuals are most desirable. Quite an extensive list of bush roses have been tested in the gardens at this station, among which the following-named varieties have made a very satisfactory performance: *Red*—Francis Scott Key, Richmond, American Beauty, Gruss an Teplitz, and Helen Gould; *pink*—Madam Abel Chatenay, La Detroit, Mrs. John Laing, Madam Caroline Testout, Antoine Rivoire, Duchess of Albany, and La France; *white*—

Kaiserin and White Killarney; *yellow*—Lady Hillingdon, Sunburst, and Perle des Jardins. The effect of open bedding with bush roses on the Yuma Experiment Farm is shown in figure 30.

DECIDUOUS SHRUBS.

A long list of flowering ornamental shrubs may be grown with success in this region. Those tested which have proven best for open plantings are the Texas Redbud (*Cercis texensis*), desert willow (*Chilopsis linearis*), *Vitex incisa* and *V. agnus-castus*, crape myrtle (*Lagerstroemia indica*), and purple-leaved plum (*Prunus pissardii*). Those which will adapt themselves to hedge plantings are flowering pomegranates (*Punica granatum*), bridal wreath (*Spirea vanhouttei* and *S. thunbergii*), and elder (*Sambucus nigra*). An open planting of crape myrtle in flower may be seen in figure 27. There is quite a varietal diversity of color in crape-myrtle shrubs. The

P6795WI

FIG. 30.—A 2-year-old bed of bush roses, with palms and eucalyptus trees in the background, on the Yuma Experiment Farm in 1918.

white, pink, and lavender colors have all developed well and produce many flowers during a long period in the summer, when the intense heat prevents most other ornamental trees and shrubs from blooming.

The reed or grasslike plants that have been successfully grown here are pampas grass and two species of bamboo (*Bambusa arundinacea* and *Dendrocalamus strictus*). The white-plumed form of pampas grass is more vigorous and uniform in development than the pink plumed variety. Plants of the latter type flower earlier in the season but do not retain the plumes as long as plants of the white type. A view of pampas grass in the edge of a ground's planting is shown in figure 26.

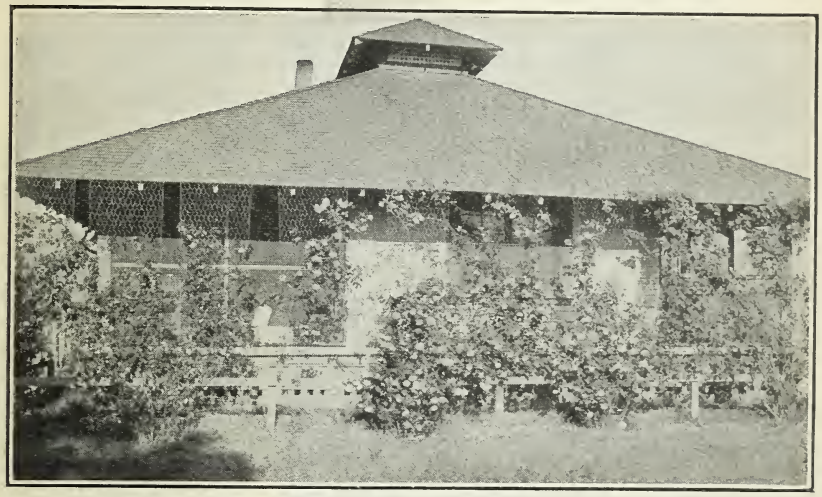
CLIMBERS AND TRAILERS.

The climbing ornamentals that grow readily in this region may be divided into the three groups, annual, evergreen, and deciduous vines. Comparatively little attention has been given to the annual climbers

in plantings made at the experiment farm. However, various varieties of morning-glories and moon vines are known to be successful. The bougainvillea is an evergreen climber which will succeed well in locations where no low winter temperatures are experienced, such as the mesa lands of the project, but does not endure the temperatures of the valley lands unless specially protected. No other evergreen climbers are grown with thorough success except the climbing roses.

CLIMBING ROSES.

Climbing roses are as superior among perennial trailers in this region as everblooming bush roses among the flowering shrubs. In



P6841W1

FIG. 31.—A row of 2-year-old climbing roses, from left to right, one bush Marechal Niel, two bushes Kaiserin, and one bush Reine Marie Henriette, growing on the Yuma Experiment Farm in 1918.

this class of roses also the everbloomers are most desirable. Among those tested, three have been found to be especially well adapted. These are: Marechal Niel, which is of a golden yellow color; Climbing Kaiserin, which is a clear white; and Reine Marie Henriette, which is red and the earliest of all roses to flower in the spring. Two-year-old plants of each of these varieties are shown in figure 31, and an older plant of Climbing Kaiserin is shown in figure 32.

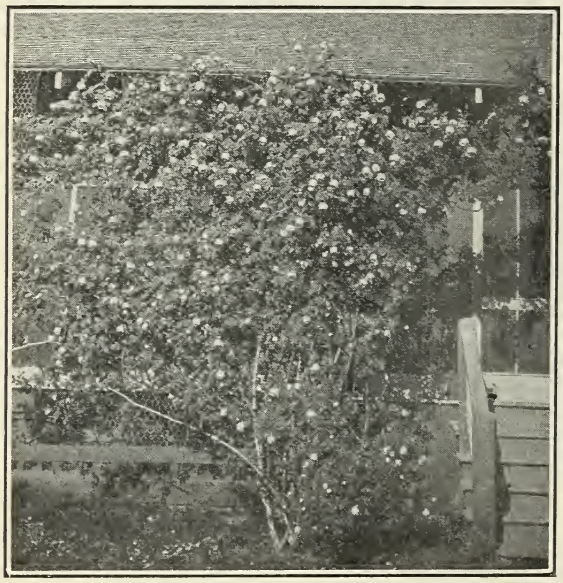
Most climbers make the best growth when grafted on rapid-growing roots. The variety Marechal Niel may be described as continually evergreen in this climate, as it has retained its foliage during winters when a minimum temperature of 17° F. has been experienced. This is a very valuable characteristic of a variety for porch plantings where a continual screen is desired. Climbing roses should be given soil and culture similar to bush roses.

DECIDUOUS CLIMBERS.

Several deciduous climbers have been found to be very suitable for trellis or porch locations, namely, the wistaria (*Wisteria sinensis* and *W. multijuga*), the kudzu vine (*Pueraria thunbergiana*), and the Virginia creeper (*Ampelopsis quinquefolia*).

PASTURING ALFALFA WITH HOGS.

A test of utilization of alfalfa by pasturing hogs as conducted during the seasons of 1916 and 1917 at this station was repeated during 1918. The pasturing test during this year, however, is not an exact replication of previous tests, as no spring herd of hogs was pastured. Spring pasturing has always proved more profitable than summer and autumn pasturing, owing no doubt to the fact that the animals have an opportunity to utilize the most vigorous growth of the alfalfa. During the high temperatures of the summer alfalfa makes a relatively small growth, and the gains of pork are correspondingly lower.



P65 13 W I

FIG. 32.—A 6-year-old rose bush, Climbing Kaiserin, on the grounds of the Yuma Experiment Farm in 1918.

A plat of hairy-leaved Peruvian alfalfa of an area of about three-quarters of an acre which had been seeded on medium-light soil in November, 1916, was fenced and divided into two equal lots in order that alternate pasturing might be practiced. Eleven fair-grade Duroc-Jersey shotes were placed on this pasture on July 29. Along with the continual access to the alfalfa pasture, these animals were fed a supplemental grain ration of cracked milo at the rate of about 2 pounds per day for each 100 pounds of live weight. The average initial weight of the pigs was 37.9 pounds, being slightly below the desirable condition of vigor when the test was started. Every animal was weighed individually each week, so that the desired grain ration for the next week might be computed. On October 14, after a grazing

period of 77 days, the available supply of cracked milo was exhausted, and it was necessary to substitute rolled barley as a supplemental grain for a period of 28 days until more milo could be secured. The same barley ration by weight was fed as of milo. There was apparently no difference in the relative pork gains during the periods that milo was fed before or after the barley and during the period when barley was the supplemental grain. As the season progressed, it was obvious that the alfalfa pasture was not supplying the necessary amount of feed, and on October 21 three hogs were removed from the test. The test was closed on November 25, after a total pasturing period of 119 days. These hogs averaged 96 pounds in weight and were sold in the local market at 14 cents per pound. Condiments consisting of a mixture of 5 pounds of slacked coal, 2 pounds of coarse salt, and 1 pound of ground rock phosphate were kept before the herd continually, and during the entire test a total of 42.5 pounds of this mixture was eaten. Table XXIX shows the gains and returns from these hogs as compared with similar experiments in 1916 and 1917.

TABLE XXIX.—*Comparative results obtained by grazing hogs on alfalfa pasture supplemented with a 2 per cent grain ration on the Yuma Experiment Farm in 1916, 1917, and 1918.*

Items of comparison.	1918	1917	1916	3-year average.
Number of lots of hogs	1	2	2	.....
Number of hogs per acre:				
For 84 days	14.02	23.33	.....	.....
For 35 days	10.2	16	24	.....
Total gain per acre ... pounds	826.7	2,747	4,813	.....
Length of pasturing period ... days	119	218	227	.....
Average daily gain per acre ... pounds	6.95	12.6	21.2	.....
Total grain fed per acre ... do	2,013	7,347	14,026	.....
Grain fed per pound of gain ... do	2.44	2.68	2.91	2.68
Gain per 100 pounds of grain ... do	41.07	37.36	34.3	37.58
Financial statement:				
Pork at 7 cents a pound and grain at 1 cent a pound—				
Net return per acre	$36.46	$117.55	$196.65	.....
Daily return per acre	.306	.539	.867	$0.571
Cost per 100 pounds of gain (pasture rent at 17.6 cents per day)	5.12	4.18	3.75	4.35
Equivalent paid by hogs for hay per ton	14.77	23.51	39.23	25.87
Pork at 14 cents a pound and grain at 3 cents a pound:				
Net return per acre	54.07	161.77	250.97	.....
Daily return per acre	.454	.742	1.11	.769
Cost per 100 pounds of gain (pasture rent at 42 cents per day)	14.12	11.45	10.77	12.11
Equivalent paid by hogs for hay per ton	21.46	32.35	50.19	44.67

In Table XXIX computations with the standard values of grain worth 1 cent a pound and pork gains worth 7 cents a pound have been considered and also the actual current values of the local market with grain worth 3 cents a pound and pork gains worth 14 cents a pound. Along with the first values mentioned, alfalfa pasture rent is worth about 17.6 cents an acre day, based on an equivalent of 5 tons of hay per acre at $8 a ton for an average nor-

mal period of 227 available pasture days. With the current schedule of values, alfalfa pasture was worth 42 cents an acre day, since during the 119-day interval of grazing, adjacent comparable fields produced 2.62 tons of hay which had a value of $20 a ton. Condiments have been figured at a value of 3 cents a pound in these calculations.

The term "net return" as used in Table XXIX refers to the difference between total values of pork gains and the value of grain and condiments consumed without deducting production cost, breeding costs, interest on investment, or risk.

In addition to the pasturing of this alfalfa plat, three cuttings of hay were harvested during April, May, and June, with a total yield at the rate of 2.55 tons of hay per acre. With hay worth $8 a ton the additional revenue of $20.40 an acre must be considered, and with hay worth $20 a ton $51 per acre must be added.

PRESERVATIVE TREATMENTS FOR WILLOW FENCE POSTS.

The Colorado River valley lands embodied in the Yuma project were originally overgrown with trees and underbrush which it was necessary to clear away before the land could be leveled and cropped. Many of these trees were the willow (*Salix nigra vallicola*), which were of sufficient size to make into fence posts. It is well known that when used for fence posts this wood decays rapidly and the posts are serviceable for only a short time. In order to ascertain whether these posts might be used profitably, several different preservative treatments have been tested at this station. In 1911 and 1912 a total of 419 willow posts, 7 feet long, straight, and not less than 5 inches at the smallest diameter, were cut and allowed to dry. Four different preservative treatments were then applied to four different lots of posts.

These treatments were as follows: (1) Posts placed in a 3 per cent solution of zinc chlorid for 2½ hours with a temperature held at 200° F.; (2) posts placed in commercial creosote maintained at a temperature of 200° F., for two hours; (3) posts dipped in commercial creosote at a temperature of 140° F., allowed to dry, and repeated until three coats were applied; (4) posts placed in crude oil at a temperature of 170° F., for 45 minutes. These posts were then set in an ordinary fence line and observed as to condition from time to time. The length of time that the posts were of service before decaying and ready to break off at the surface of the ground was recorded and is expressed in Table XXX.

All of these posts were serviceable for about four years, and a very few are still in fair condition at the end of seven years' service. Table XXX shows that the second treatment was much the most effective of the four.

TABLE XXX.—*Effectiveness of four rot-preventive treatments for willow fence posts on the Yuma Experiment Farm during the 7-year period from 1912 to 1918.*

Method of treatment.	Apparent depth of penetration.	Number of posts treated.	Length of life of posts (percentage of total).		
			Only 4 years.	4 to 5 years.	6 to 7 years.
Zinc chlorid, 3 per cent solution, soaked for 2½ hours	Three-fourths inch	115	48	19	33
Creosote, soaked for 2 hours	One inch	13	.....	23	77
Creosote, dipped three times	One-sixteenth inch	24	83.4	8.3	8.3
Crude oil, soaked for 45 minutes	One-eighth inch	267	70	13	17

IRRIGATION REQUIREMENTS.

The water requirements and diversions for the Yuma project during 1918, as accounted for by the United States Reclamation Service, are given in brief in Table XXXI. Water recorded as unused is that lost by evaporation and seepage from canals, and also the amount turned back into the Colorado River through wasteways. An average of 3.29 acre-feet per acre was applied to cultivated land of the project in 1918, as compared to 3.7 acre-feet in 1917.

TABLE XXXI.—*Comparative water requirement for the Yuma Reclamation Project in 1916, 1917, and 1918.*

Month.	Water measurements.							
	Total diverted in 1918.	Unused in 1918.	Delivered to farms.					
			Total in 1918.	Part of total in 1918	Per acre irrigated.			
					1918	1917	1916	3-year average.
	Acre-ft.	*Acre-ft.*	*Acre-ft.*	*Per cent.*	*Acre-ft.*	*Acre-ft.*	*Acre-ft.*	*Acre-ft.*
January	8,752	6,605	2,147	1.42	0.05	0.06	0.07	0.06
February	11,386	8,621	2,765	1.84	.06	.20	.12	.13
March	31,929	17,833	14,096	9.38	.31	.37	.28	.32
April	33,938	18,780	15,158	10.09	.33	.36	.31	.33
May	32,385	18,526	13,859	9.22	.30	.42	.33	.35
June	35,862	17,755	18,107	12.05	.40	.44	.45	.43
July	47,753	21,610	26,143	17.40	.57	.46	.39	.47
August	42,690	17,244	25,446	16.94	.56	.48	.48	.51
Septemebr	35,979	16,879	19,100	12.71	.42	.43	.36	.40
October	21,881	11,635	10,246	6.82	.22	.28	.22	.24
November	8,096	6,490	1,606	1.07	.04	.09	.12	.08
December	6,249	4,693	1,556	1.04	.03	.11	.07	.07
Total for year	316,900	166,671	150,229	100	3.29	3.7	3.20	3.39

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